THE UNIVERSITY OF ALBERTA

AUDITORY REGIONS OF STREPSIRHINE PRIMATES, TREE SHREWS, ELEPHANT SHREWS, AND LIPOTYPHLOUS INSECTIVORES: AN ONTOGENETIC PERSPECTIVE ON CHARACTER ANALYSIS

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF ANTHROPOLOGY

EDMONTON, ALBERTA

FALL, 1977

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(Volume II)

F I G U R E S

FIG. I-1 Left auditory region of a hypothetical placental mammal (schematic), prior to the formation of extensive tympanic processes and epitympanic wings (cf. figs. I-2, I-3). Most of the important features and landmarks discussed in section 1.4 are identified, although some (e.g., ectotympanic, cartilage of the auditory tube) have been removed to provide an unobstructed view of dorsal structures. Reichert's cartilage is cut close to its base.

1, anterior basicapsular commissure; 2, remnant of processus alaris, marking division between basisphenoid and alisphenoid; 3, alicochlear commissure; 4, posterior basicapsular commissure.

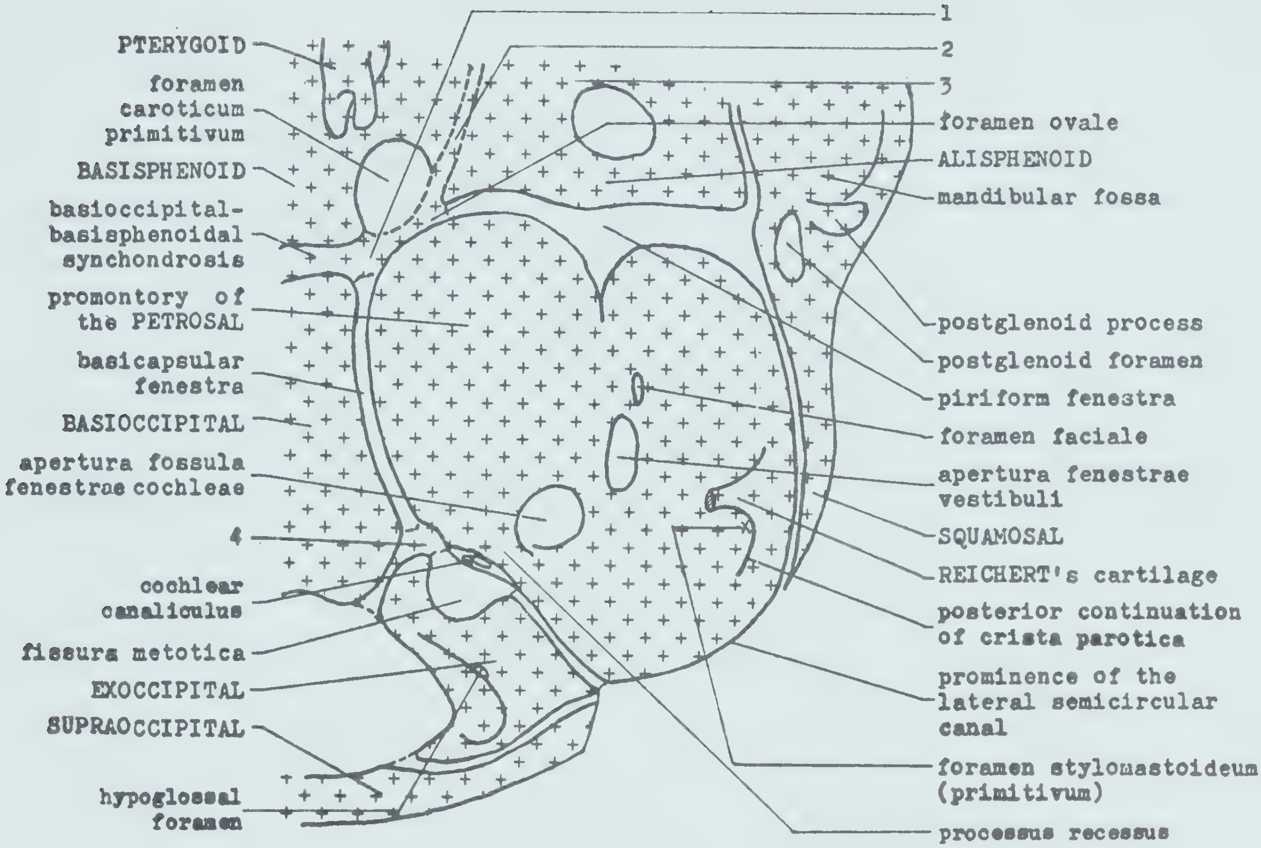

1
2
3
PTERYGOID
foramen caroticum primitivum
BASISPHENOID
basioccipital-basisphenoidal synchondrosis
promontory of the PETROSAL
basicapsular fenestra
BASIOCCIPITAL
apertura fossula fenestrae cochleae
4
cochlear canaliculus
fissura metotica
EXOCCIPITAL
SUPRAOCCIPITAL
hypoglossal foramen
foramen ovale
ALISPHENOID
mandibular fossa
postglenoid process
postglenoid foramen
piriform fenestra
foramen faciale
apertura fenestrae vestibuli
SQUAMOSAL
REICHERT's cartilage
posterior continuation of crista parotica
prominence of the lateral semicircular canal
foramen stylomastoideum (primitivum)
processus recessus

FIG. I-2 Tympanic processes vary greatly in their form and disposition in adult mammals. However, the available sample suggests that there is a good deal of uniformity in the sites of <u>initial</u> origin of these outgrowths. This diagram is a composite; no form investigated here possesses outgrowths at all the sites indicated by stippling. Nevertheless, it reflects with reasonable accuracy those areas which are commonly implicated in the production of tympanic processes, and their relative placement at an early stage of development.

See fig. I-1 for names and locations of other anatomical features. Ectotympanic, entotympanics, and tympanic processes of mammals other than those investigated here are not illustrated.

SF, fossa for stapedius m.; D_3, diverticulum containing saccus posterior of cavum tympani.

1, tympanic process of basisphenoid (sometimes incorporates posterior part of pterygoid)
2, tympanic process of alisphenoid
3, entoglenoid process of squamosal
4, rostral tympanic process of petrosal
5, caudal tympanic process of petrosal, divided into three components:

5a, medial section
5b, posterior section
5c', lateral section, in certain mammals (e.g., tupaioids)
5c", lateral section, in certain mammals (e.g., strepsirhines)

4 + 5 = petrosal plate

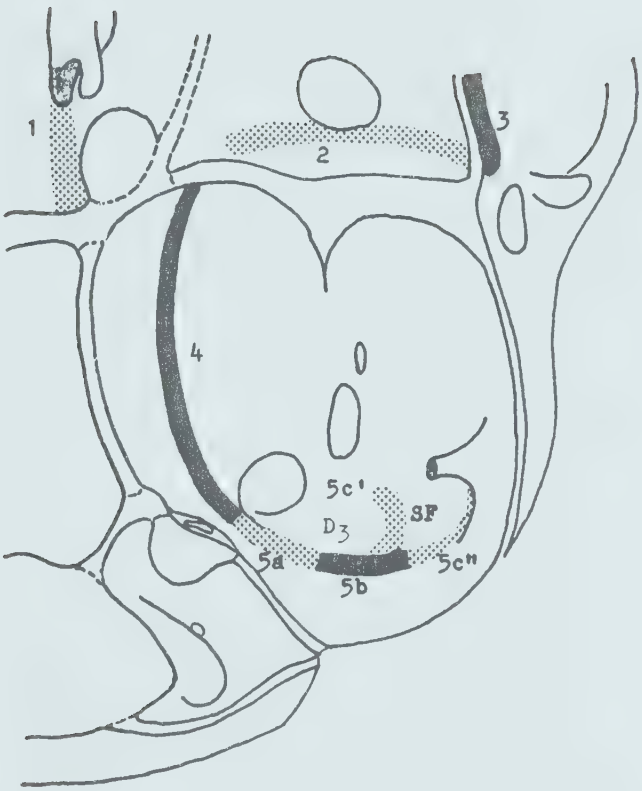

1
2
3
4
5c'
SF
D3
5a
5b
5c"

FIG. I-3 One of the major growth areas of the basicranium is situated along a frontal axis passing through the basioccipital-basisphenoidal synchondrosis and the piriform fenestra. Endochondral growth at the synchondrosis results in the considerable elongation of this part of the basicranium. Accompanying growth occurs along the margins of the piriform fenestra. If growth is sufficient in the latter case, the fenestra will eventually close or reduce to a narrow fissure (petrosphenoid suture); if not, the fenestra will be retained as a ragged breach into adult life.

The pointers indicate directions of growth along the axis described above. No attempt is made to illustrate the growth of the basicranium as a whole.

This diagram is a composite in the same sense as fig. I-2, but section 1.4.2 should be consulted for its proper interpretation. The numbers identify areas of potential growth around the piriform fenestra (see key adjacent to diagram).

1, epitympanic wing of sphenoid (which includes, in many cases, contributions from both the basisphenoid [1a] and alisphenoid [1b]); 2, epitympanic wing of petrosal; 3, tegmen tympani (here depicted as relatively large); 4, epitympanic wing of squamosal.

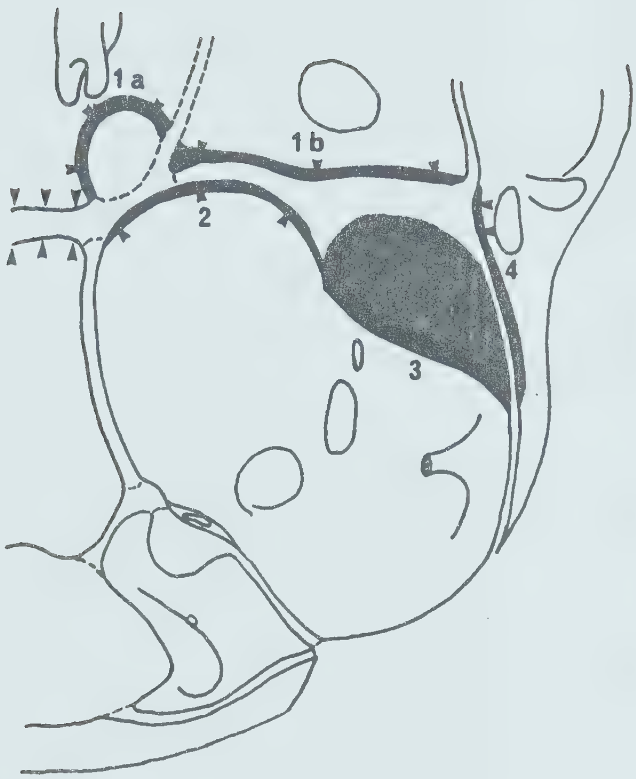

1a
1b
2
3
4

FIG. I-4 Plan of chief arteries and nerves traversing the auditory region of a hypothetical placental mammal. Only major branches and connexions are illustrated. Relative sizes of arteries and nerves are representational only, and no scale is implied. See definitions in appendix II for further information.

1, cerebral carotid a. (in this case, formed by the anastomosis of the anterior carotid and promontorial aa.); 2, branch of internal carotid n., to cavernous plexus; 3, tympanic plexus.

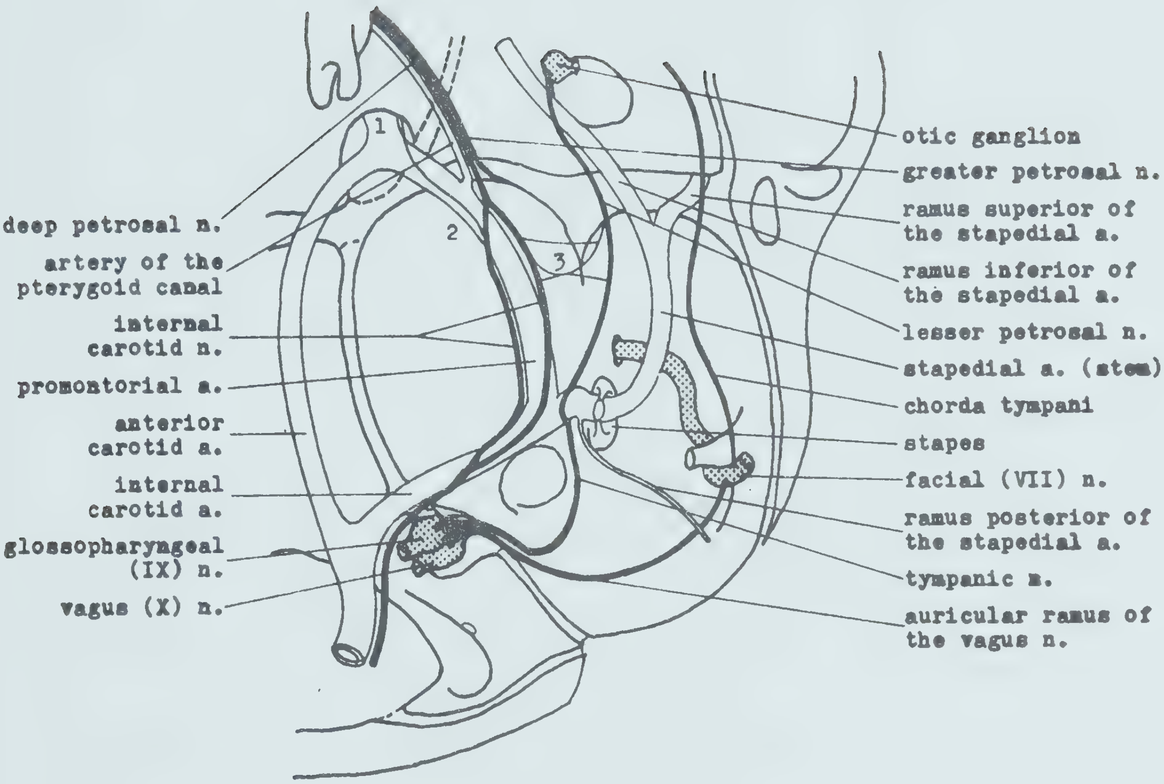

deep petrosal n.
artery of the pterygoid canal
internal carotid n.
promontorial a.
anterior carotid a.
internal carotid a.
glossopharyngeal (IX) n.
vagus (X) n.
1
2
3
otic ganglion
greater petrosal n.
ramus superior of the stapedial a.
ramus inferior of the stapedial a.
lesser petrosal n.
stapedial a. (stem)
chorda tympani
stapes
facial (VII) n.
ramus posterior of the stapedial a.
tympanic n.
auricular ramus of the vagus n.

FIG. II-1 *M. murinus* MPIH 1962/57 (fetus). Reconstruction of left auditory region and associated structures, ca. x 20. Areas marked by widely-spaced dots represent zones of primary cartilage; open circles represent secondary cartilage. Remaining areas are bony.

a. General anatomy.

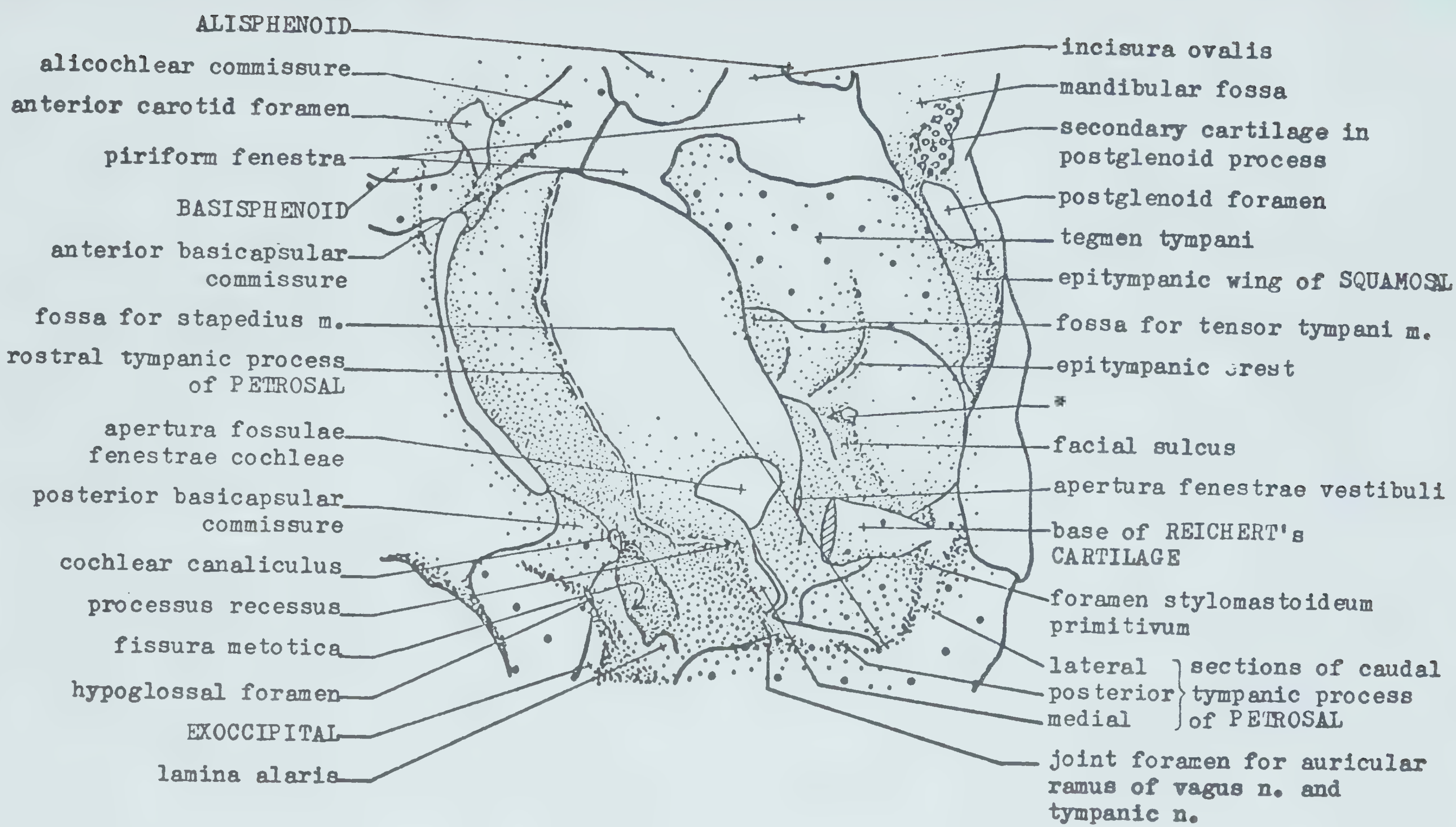
b. Ectotympanic, Reichert's cartilage and the cartilage of the auditory tube *in situ*.

c. Routes of arteries and nerves.

The rostral tympanic process of the petrosal forms an even arc of trabeculae along the middle of the ventral surface of the promontory, directly above the ectotympanic. The caudal tympanic process of the petrosal arises in cartilage in the hind part of the presumptive middle ear. The two processes meet on the processus recessus (medial wall of apertura fossulae fenestrae cochleae).

Parts of the internal carotid n. and a. which would not be visible from this aspect are indicated by dashed lines. Similarly, the anterior part of the tympanic n. has not been drawn in, since the nerve would appear to intersect or overlap the internal carotid n. from this aspect. Despite the appearance given by the drawing, the lesser petrosal n. arises from the tympanic plexus (not visible) as usual, and not from the internal carotid n.

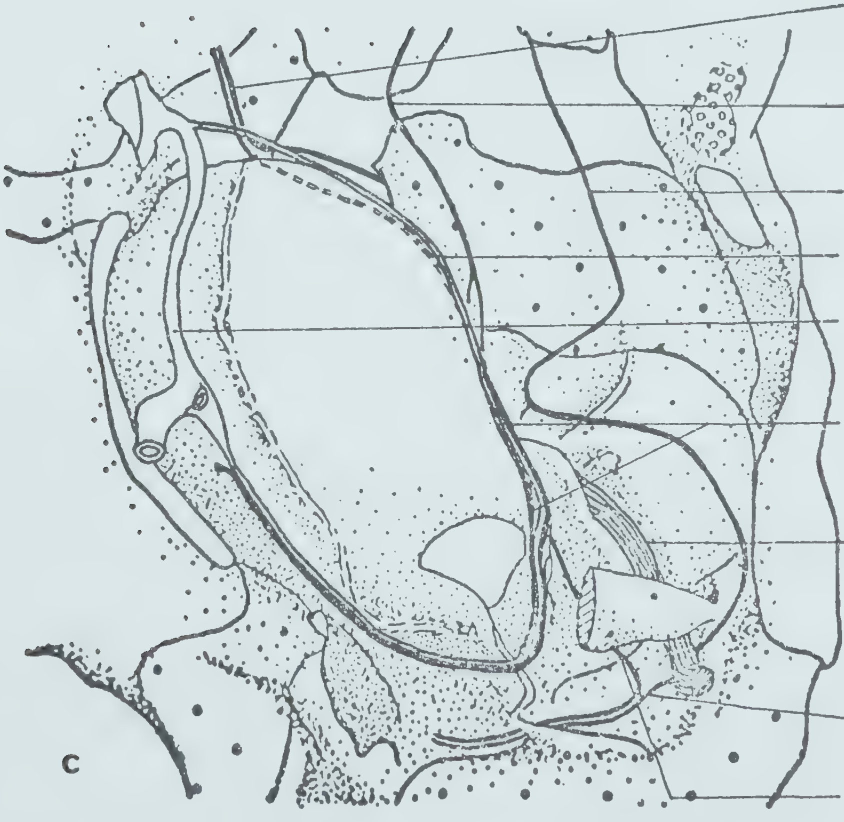
*, foramen for a vein (stapedial a. absent in this specimen; cf. fig. II-2).


ALISPHENOID
alicochlear commissure
anterior carotid foramen
piriform fenestra
BASISPHENOID
anterior basicapsular commissure
fossa for stapedius m.
rostral tympanic process of PETROSAL
apertura fossulae fenestrae cochleae
posterior basicapsular commissure
cochlear canaliculus
processus recessus
fissura metotica
hypoglossal foramen
EXOCCIPITAL
lamina alaris
incisura ovalis
mandibular fossa
secondary cartilage in postglenoid process
postglenoid foramen
tegmen tympani
epitympanic wing of SQUAMOSAL
fossa for tensor tympani m.
epitympanic crest
*
facial sulcus
apertura fenestrae vestibuli
base of REICHERT's CARTILAGE
foramen stylomastoideum primitivum
lateral
posterior
medial
sections of caudal tympanic process of PETROSAL
joint foramen for auricular ramus of vagus n. and tympanic n.

a


cartilage of the auditory tube
stylohyal
Reichert's cartilage
ectotympanic

b


greater petrosal n.
lesser petrosal n.
chorda tympani
promontorial a.
anterior carotid a.
internal carotid n.
facial n.
ramus auricularis vagi
tympanic n. (to lesser petrosal n.)

c

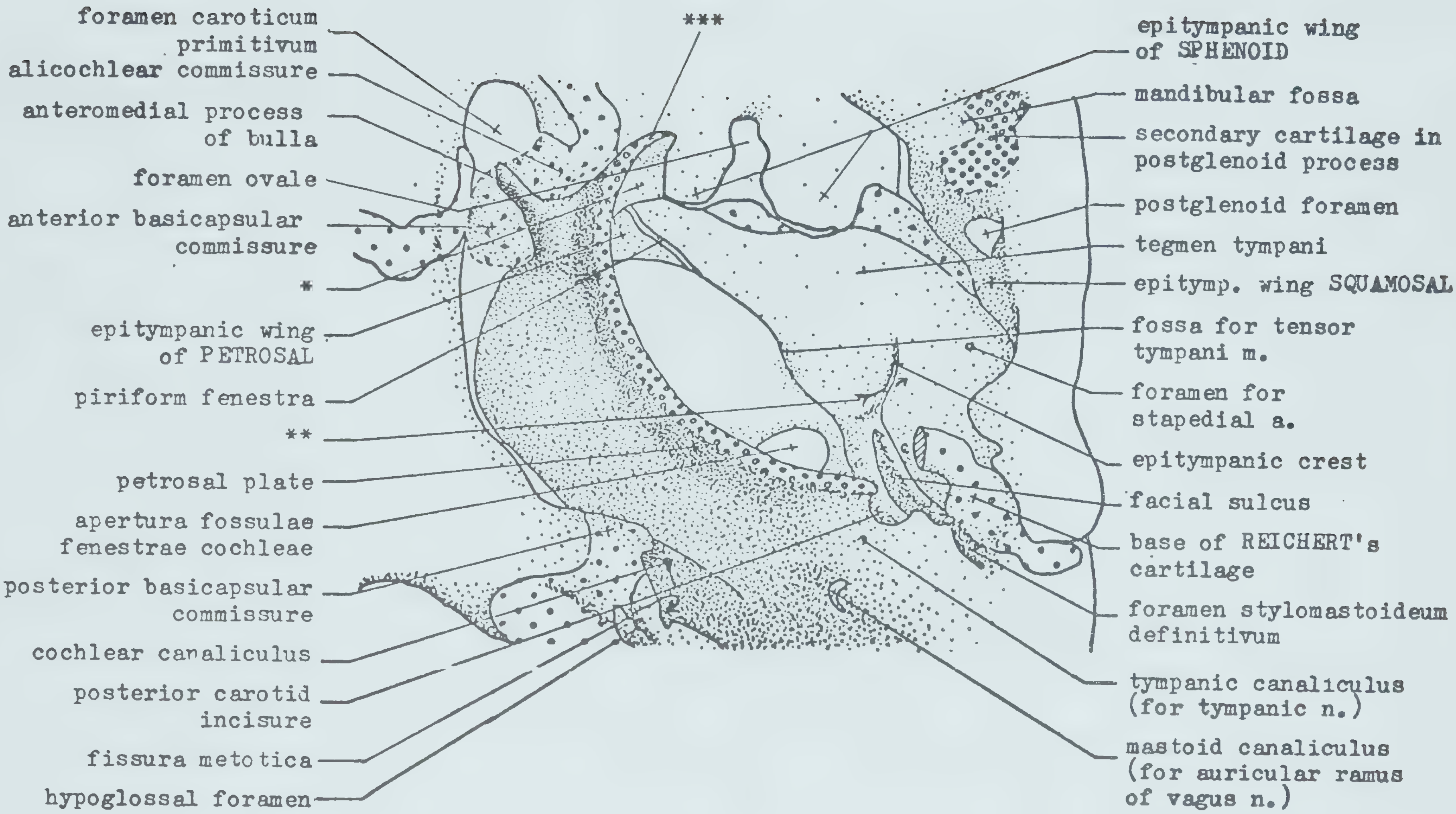
FIG. II-2 _M. murinus_ MPIH 1964/42 (fetus). Reconstruction of left auditory region and associated structures, ca. x 20. See fig. II-1 for shading conventions.

a. General anatomy; ca. x 20.

b. Ectotympanic, Reichert's cartilage, and the cartilage of the auditory tube _in situ_; ca. x

The petrosal plate has attained large size and shows some degree of inflation, especially in its anterior part. The rostral and caudal tympanic processes of the petrosal now constitute a single rampart of bone (the petrosal plate). The ectotympanic is still visible, although the extreme anterior end of the petrosal plate is just beginning to overlap it (***). Note the presence of secondary cartilage in the ventral part of the petrosal plate.

Only the divisions of the internal carotid a. are shown in this diagram; for routes of nerves, see fig. II-1. Note that (a) the position of the entry-point of the internal carotid a. into the tympanic cavity has shifted to the posterior relative to conditions in MPIH 1962/57 (fig. II-1); (b) the stapedial a. is present and passes through the epitympanic crest; and (c) the promontorial a. travels along the remnant portion of the piriform fenestra.


foramen caroticum primitivum
alicochlear commissure
anteromedial process of bulla
foramen ovale
anterior basicapsular commissure
*
epitympanic wing of PETROSAL
piriform fenestra
**
petrosal plate
apertura fossulae fenestrae cochleae
posterior basicapsular commissure
cochlear canaliculus
posterior carotid incisure
fissura metotica
hypoglossal foramen
***
epitympanic wing of SPHENOID
mandibular fossa
secondary cartilage in postglenoid process
postglenoid foramen
tegmen tympani
epitymp. wing SQUAMOSAL
fossa for tensor tympani m.
foramen for stapedial a.
epitympanic crest
facial sulcus
base of REICHERT's cartilage
foramen stylomastoideum definitivum
tympanic canaliculus (for tympanic n.)
mastoid canaliculus (for auricular ramus of vagus n.)

a

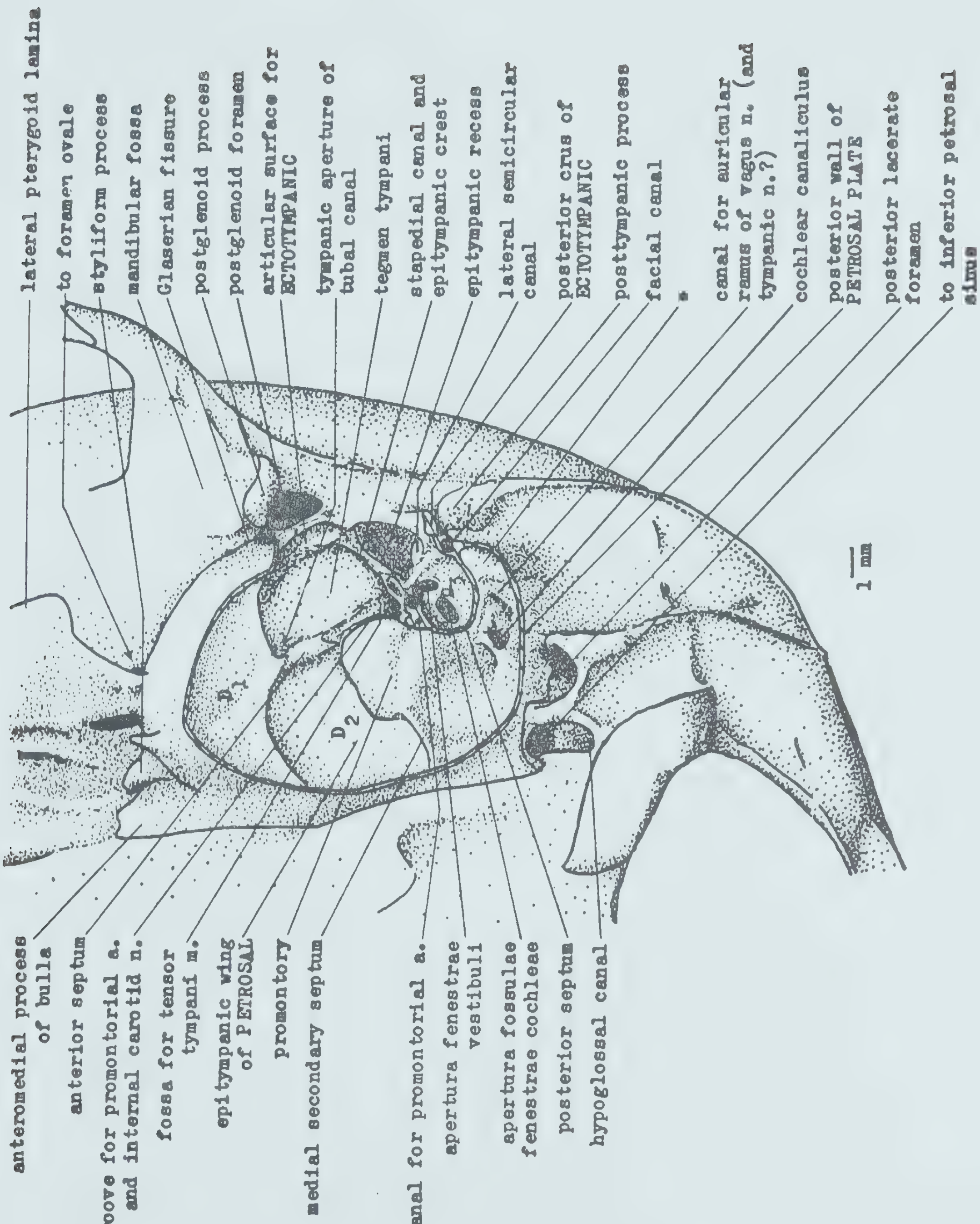

cartilage of the auditory tube
accessory cartilage
promontorial a.
ectotympanic
stapedial a.
Reichert's cartilage
internal carotid a.

b

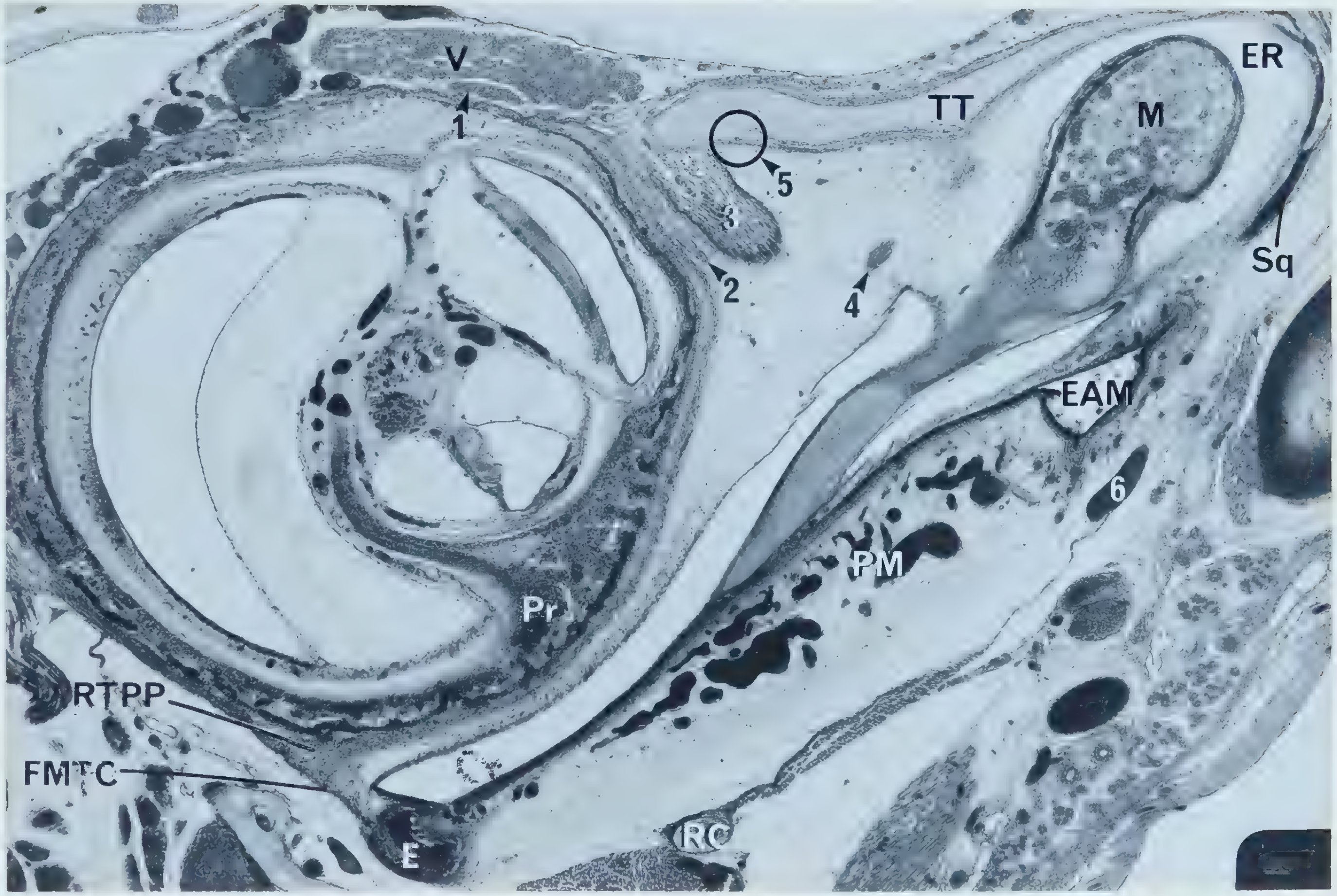
FIG. II-3 *L. catta* adult. General view of left auditory region, ventral aspect.

Most of the ventral part of the bulla (petrosal plate) and the ectotympanic have been removed. Note that the massively inflated petrosal plate has migrated medially and no longer occupies the center of the ventral surface of the promontory (see fig. II-2). The posterior septum, however, occupies the position of the original caudal tympanic process of the petrosal.

*, posterior diverticulum of the hypotympanic sinus.


lateral pterygoid lamina
to foramen ovale
styliform process
mandibular fossa
Glaserian fissure
postglenoid process
postglenoid foramen
articular surface for ECTOTYMPANIC
tympanic aperture of tubal canal
tegmen tympani
stapedial canal and epitympanic crest
epitympanic recess
lateral semicircular canal
posterior crus of ECTOTYMPANIC
posttympanic process
facial canal
*
canal for auricular ramus of vagus n. (and tympanic n.?)
cochlear canaliculus
posterior wall of PETROSAL PLATE
posterior lacerate foramen
to inferior petrosal sinus
D_1
D_2
1 mm
anteromedial process of bulla
anterior septum
groove for promontorial a. and internal carotid n.
fossa for tensor tympani m.
epitympanic wing of PETROSAL
promontory
medial secondary septum
canal for promontorial a.
apertura fenestrae vestibuli
apertura fossulae fenestrae cochleae
posterior septum
hypoglossal canal

1, greater petrosal n.; 2, promontorial a. and internal carotid n.;
3, tensor tympani m.; 4, chorda tympani; 5, lesser petrosal n.;
6, auricular cartilage; 7, anterior carotid a.


V
1
TT
M
ER
5
3
Sq
2
4
EAM
6
PM
Pr
RTPP
FMTC
E
RC

507

FIG. II-5 *M. murinus* MPIH 1962/57 (fetus); s. 102/1/2, cross-section, left side (sides rev.); Azan; x 38.

Growth of petrosal plate II. The trabeculae composing the rostral tympanic process now form a prominent ridge (see also fig. II-1).

The ridge on the underside of the tegmen tympani is the epitympanic crest. The lesser petrosal n. is within the fossa for the tensor tympani and cannot be easily distinguished in this photograph.

For key to numbered structures, see fig. II-4.

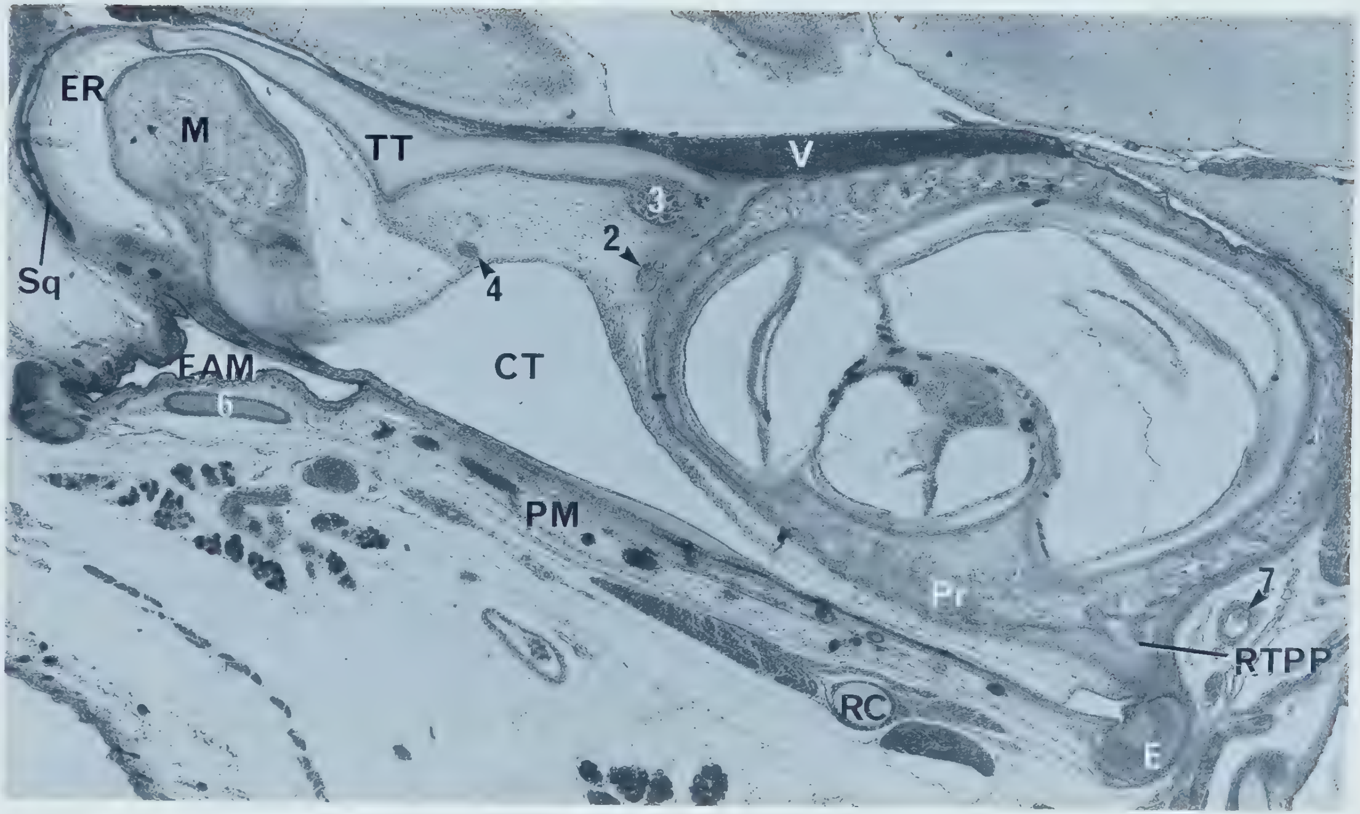

ER
M
Sq
TT
EAM
6
3
2
4
CT
PM
V
Pr
RC
E
7
RTPP

FIG. II-6 *M. murinus* MPIH 1964/43 (fetus); s. 1124, cross-section, left side; Azan; x 29.

Growth of the petrosal plate III. The petrosal plate is substantially larger, but still occupies the middle of the ventral surface of the promontory.

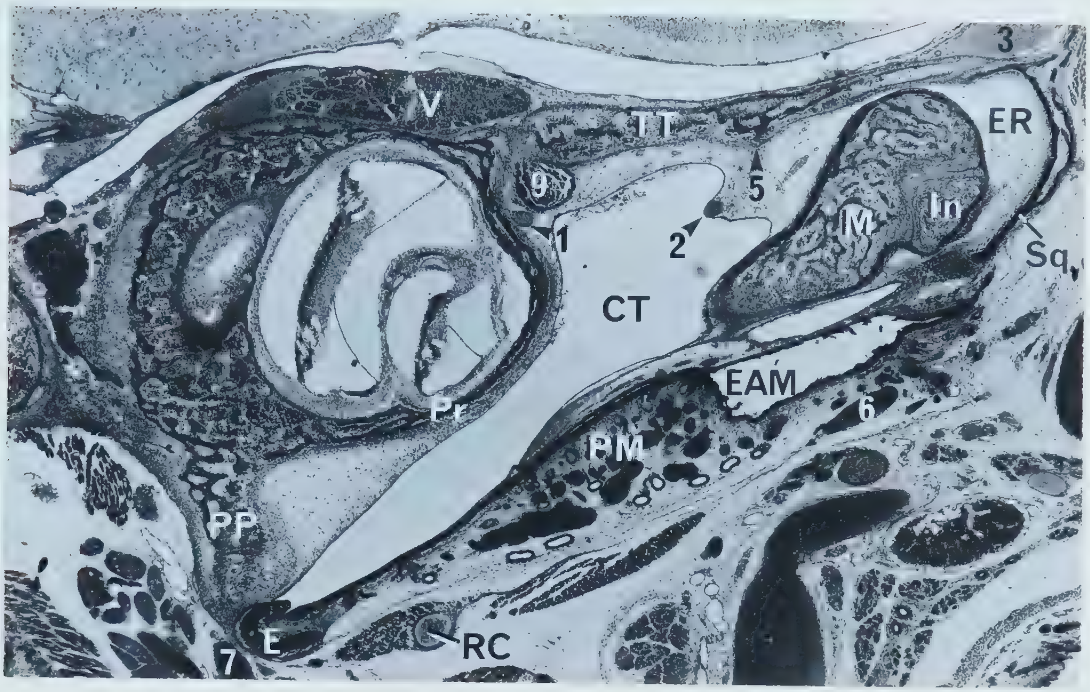
1, promontorial a. and internal carotid n.; 2, chorda tympani; 3, petrosquamous sinus; 4, stapedial a. passing through foramen in tegmen tympani; 5, epitympanic crest; 6, auricular cartilage; 7, anterior carotid a.; 8, cranial cervical ganglion; 9, tensor tympani.

FIG. II-7 *M. murinus* MPIH 1964/42 (fetus); s. 1120, cross-section, left side; Azan; x 28.

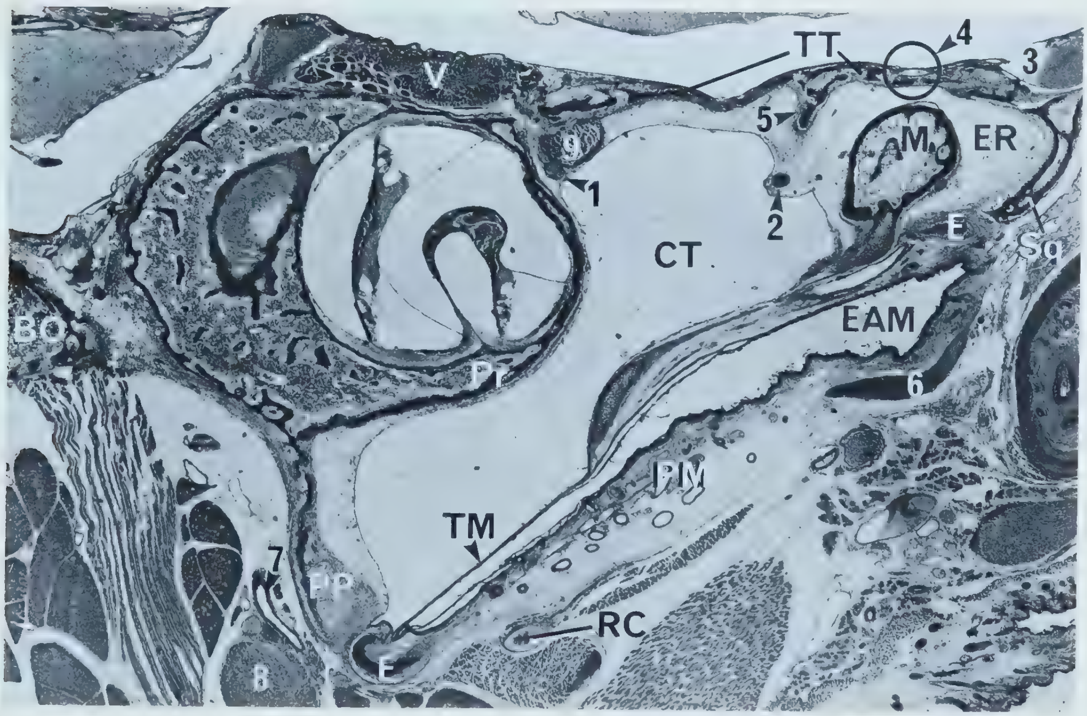
Growth of the petrosal plate IV. The petrosal plate is not significantly larger in this specimen than in the preceding one, but the ventral part of the plate is composed of secondary cartilage.

The stapedial a. is complete in MPIH 1964/42, and anastomizes with the middle meningeal (cf. fig. II-6).

For key to numbered structures, see fig. II-6.



3
V
TT
ER
9
5
2
1
M
In
Sq
CT
EAM
6
Pr
PM
PP
E
7
RC

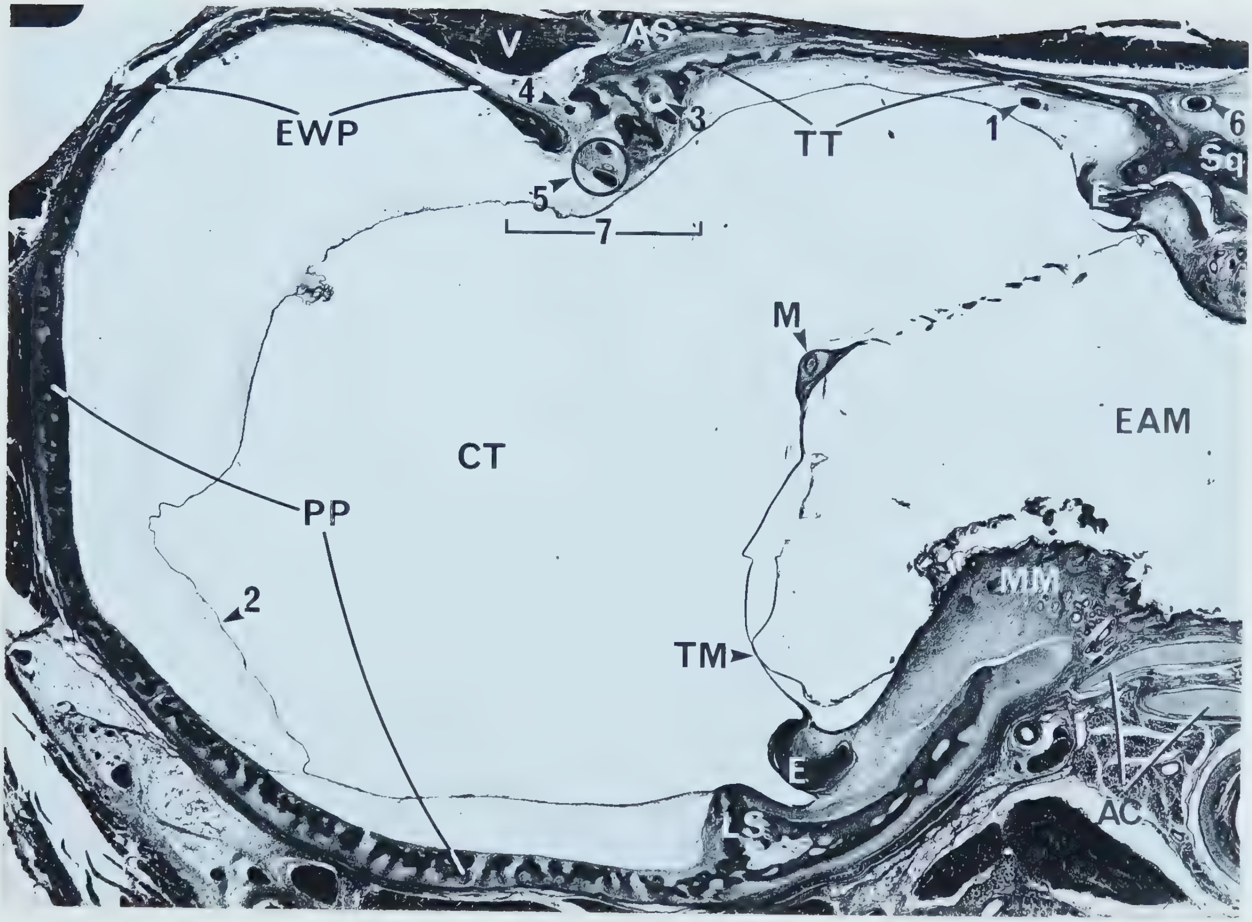


TT
4
3
V
5
M
ER
9
1
2
CT
E
Sq
EAM
BO
Pr
6
PM
TM
7
PP
RC
8
E

FIG. II-8 L. catta MPIH 1964/28 (10 days old); s. 2410, cross-section, left side; Azan; x 20.

Growth of petrosal plate V. The petrosal plate is already greatly inflated in this specimen. The plate has grown around the ectotympanic, which is now intrabullar in position. The anterior septum is formed by the everted margins of the tegmen tympani and epitympanic wing of the petrosal, along the persistent remnant of the piriform fenestra.

1, chorda tympani; 2, tunica mucosa; 3, lesser petrosal n.; 4, greater petrosal n.; 5, promontorial a. and internal carotid n.; 6, middle meningeal a. (from stapedial a.); 7, anterior septum.


V
AS
4
3
EWP
TT
1
6
Sq
5
E
7
M
EAM
CT
PP
MM
2
TM
E
LS
AC

513

FIG. II-9 M. murinus MPIH 1964/41 (fetus); s. 905, cross-section, left side; Azan; x 114.

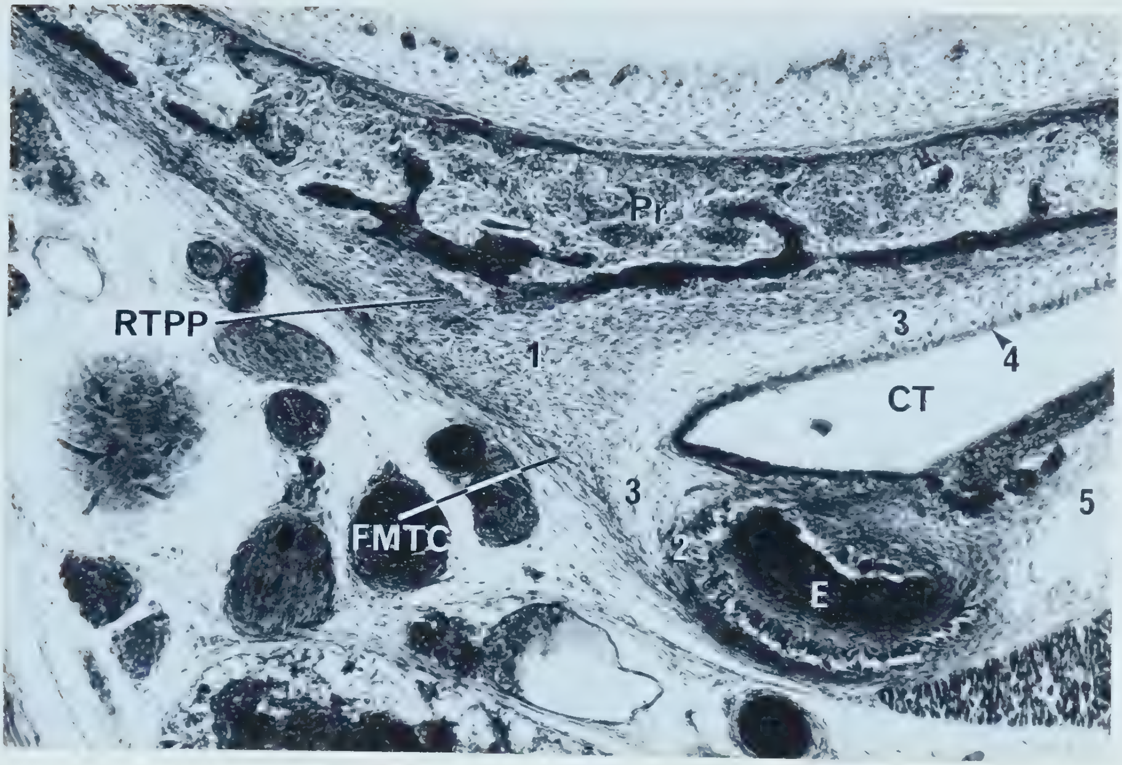
Relationship of ectotympanic and petrosal plate I. In this youngest specimen, the anterior part of the petrosal plate (rostral tympanic process of the petrosal) is a low ridge of trabeculae developing within a periosteal thickening on the promontory. Tympanic mucoid tissue (3) intervenes between the capsular layers of the petrosal plate and ectotympanic (1,2).

1, capsular layer of the petrosal plate; 2, capsular layer of the ectotympanic; 3, tympanic mucoid tissue; 4, epithelium of presumptive tunica mucosa; 5, presumptive tissues of membranous meatus.

FIG. II-10 M. murinus MPIH 1962/57 (fetus); s. 102/1/2, cross-section, left side; Azan; x 73.

Relationship of ectotympanic and petrosal plate II. As indicated by the outline arrows, the capsular layers of the petrosal plate and ectotympanic are now contiguous; tympanic mucoid tissue no longer separates them. No separate middle layer is identifiable.

For key to numbered structures, see fig. II-9.


Pr
RTPP
1
3
4
CT
3
5
FMTC
2
E

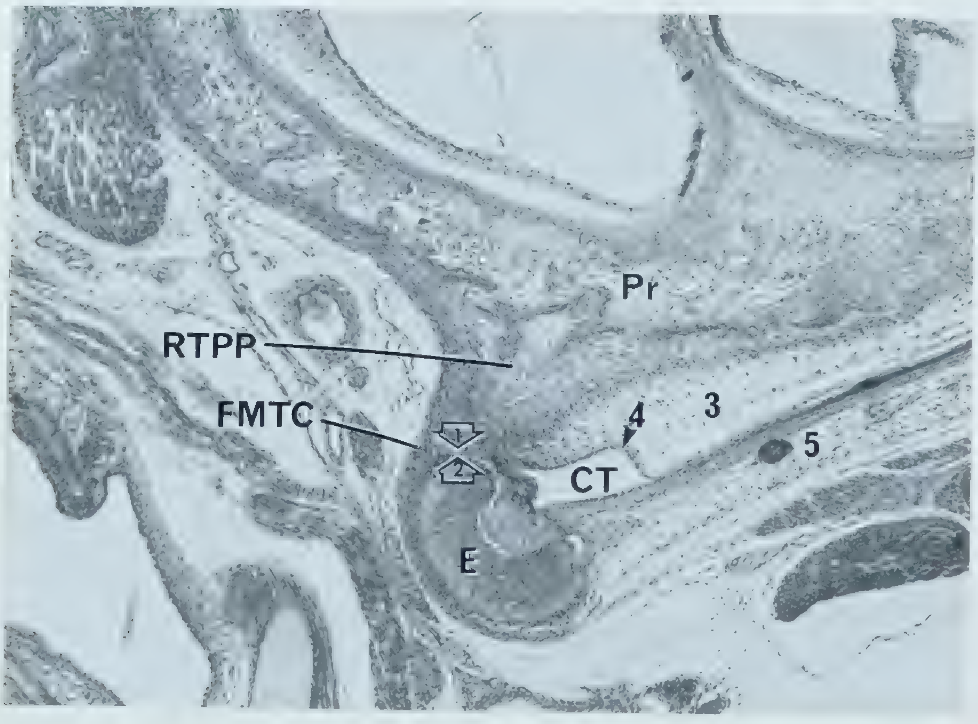

Pr
RTPP
FMTC
1
2
4
3
5
CT
E

FIG. II-11 *M. murinus* MPIH 1964/43 (fetus); s. 1032, cross-section, right side (sides rev.); Azan; x 120.

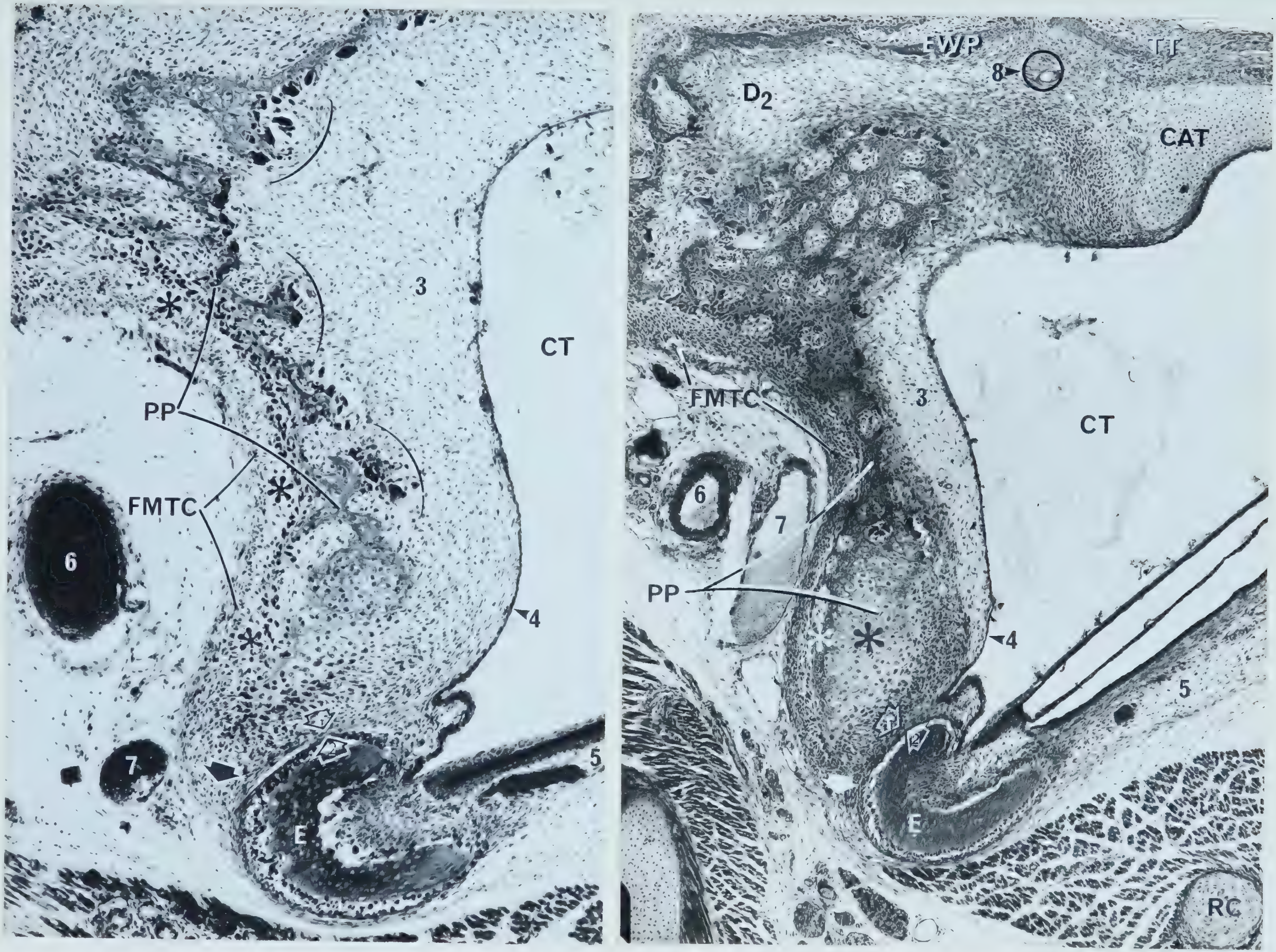
Relationship of ectotympanic and petrosal plate III. No middle layer separates the still-contiguous capsular layers of the ectotympanic and petrosal plate (outline arrows). Osteoblasts (asterisks) densely coat the medial and ventral surfaces of the petrosal plate, while osteoclasts (brackets) can be detected along its lateral surface. Note that the ventromedial edge of the petrosal plate is beginning to grow around the ectotympanic. A lateral uniting layer is seemingly absent.

1, capsular layer of the petrosal plate; 2, capsular layer of the ectotympanic; 3, tympanic mucoid tissue; 4, epithelium of presumptive tunica mucosa; 5, presumptive tissues of membranous meatus; 6, anterior carotid a.; 7, petro-occipital sinus; 8, promontorial a. and internal carotid n.

FIG. II-12 *M. murinus* MPIH 1964/42 (fetus); s. 1028, cross-section, left side; hematoxylin and eosin; x 84.

Relationship of the ectotympanic and petrosal plate IV. The chief difference between this specimen and MPIH 1964/43 (fig. II-11) is the presence of secondary cartilage in the ventral part of the petrosal plate (black asterisk). A splint of bone of normal appearance (white asterisk) medially bounds the area of secondary cartilage. As before, no middle layer can be distinguished between the contiguous capsular layers.

For key to numbered structures, see fig. II-11.



3
CT
PP
FMTC
6
4
7
5
E
EWP
TT
8
D2
CAT
RC

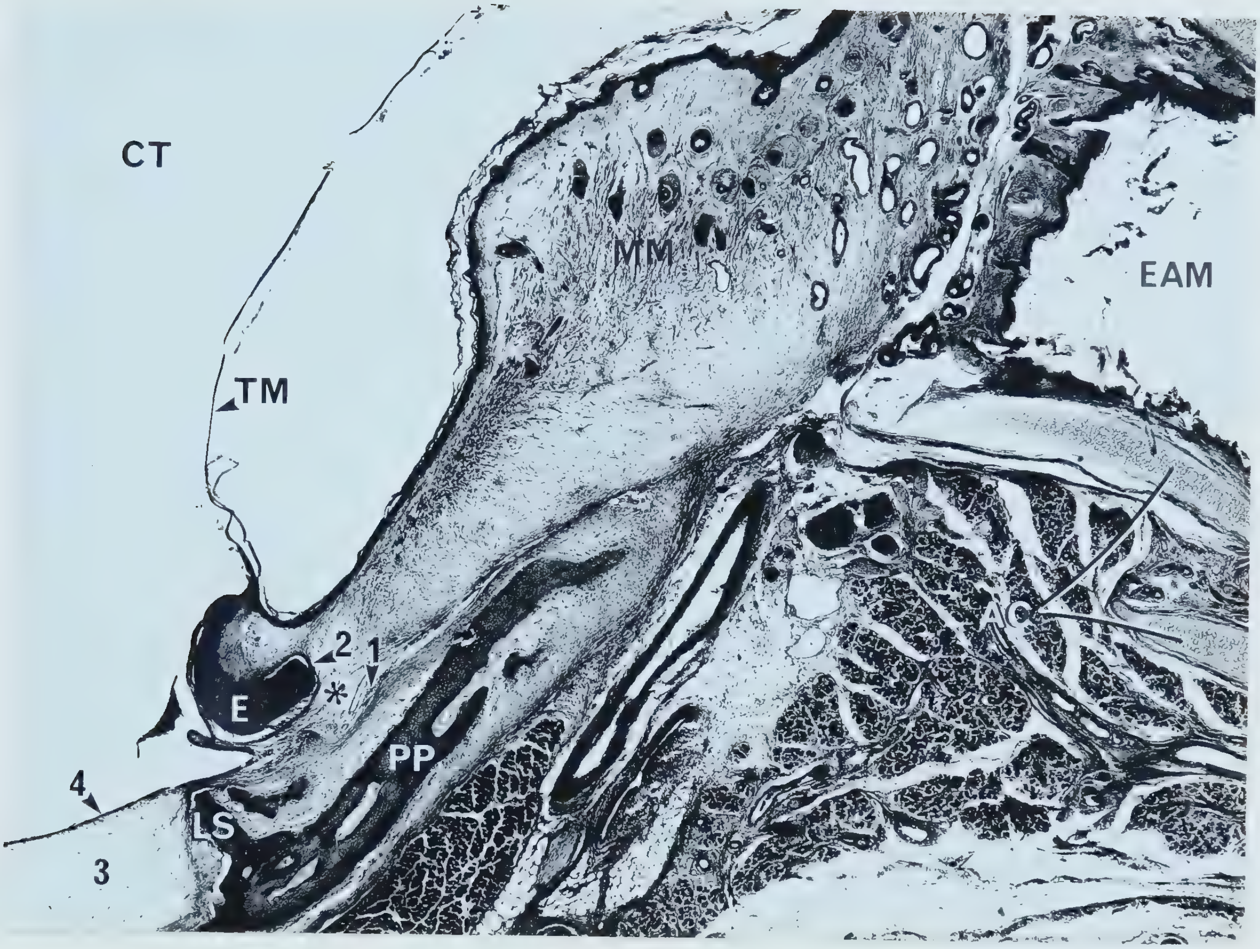
FIG. II-13 L. catta MPIH 1964/28 (10 days old); s. 2320, cross-section, left side; Azan; x 33.

Relationship of ectotympanic and petrosal plate V. The petrosal plate has completely encircled the ectotympanic, and the ectotympanic-petrosal plate relationship has reached its definitive condition. The ectotympanic does not form a suture with the petrosal plate in postnatal life. It remains embedded, as before, within the dermal layer of the membranous meatus, part of which (asterisk) separates the periosteum of the ectotympanic (2) from that of the internal wall of the bulla (1). The fibrous membrane of the tympanic cavity cannot be distinguished from the periosteal tissues lining the external surface of the bulla.

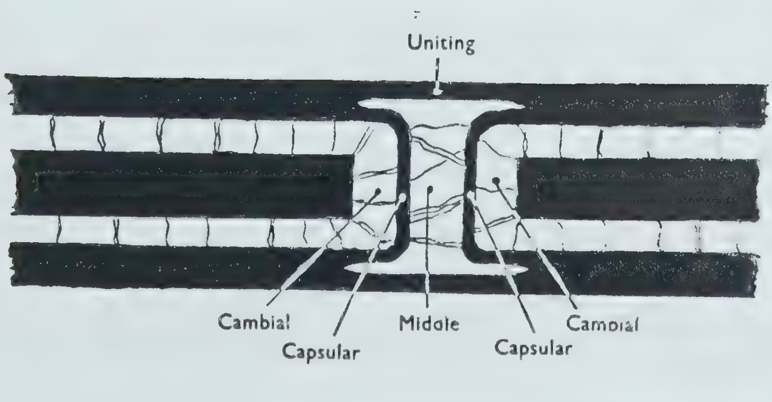
Note the absence of any 'anulus membrane' independent of the tissue forming the membranous meatus, and the extrabullar situation of the auricular cartilage.

For key to numbered structures, see fig. II-11.

FIG. II-14 Schema of sutural layers in a typical suture (after PRITCHARD et al., 1956).



CT
TM
MM
EAM
AC
2
1
*
E
PP
4
LS
3



Uniting
Cambial
Capsular
Middle
Capsular
Cambial

FIG. II-15 *M. murinus* MPIH 1964/41 (fetus); s. 1020, cross-section, left side; Azan; x 28.

Posterior part of presumptive tympanic cavity. The processus recessus is mostly cartilaginous at this stage. Besides defining the ventral limits of the future cochlear canaliculus (accommodating the perilymphatic duct) and the fossula fenestrae cochleae (containing the secondary tympanic membrane), the lateral margin of the processus recessus contributes to the medial part of the caudal tympanic process of the petrosal.

1, tympanic n.; 2, internal carotid a. passing into tympanic cavity; 3, internal carotid n.; 4, stapedius m.; 5, posterior continuation of the crista parotica (serving as lateral section of CTPP); 6, FMTC; 7, medial section of CTPP; 8, vein passing through joint foramen for tympanic n. and auricular ramus of vagus; 9, auricular ramus of vagus; 10, posterior section of CTPP.

FIG. II-16 *M. murinus* MPIH 1964/41 (fetus); s. 1045, cross-section, left side; Azan; x 43.

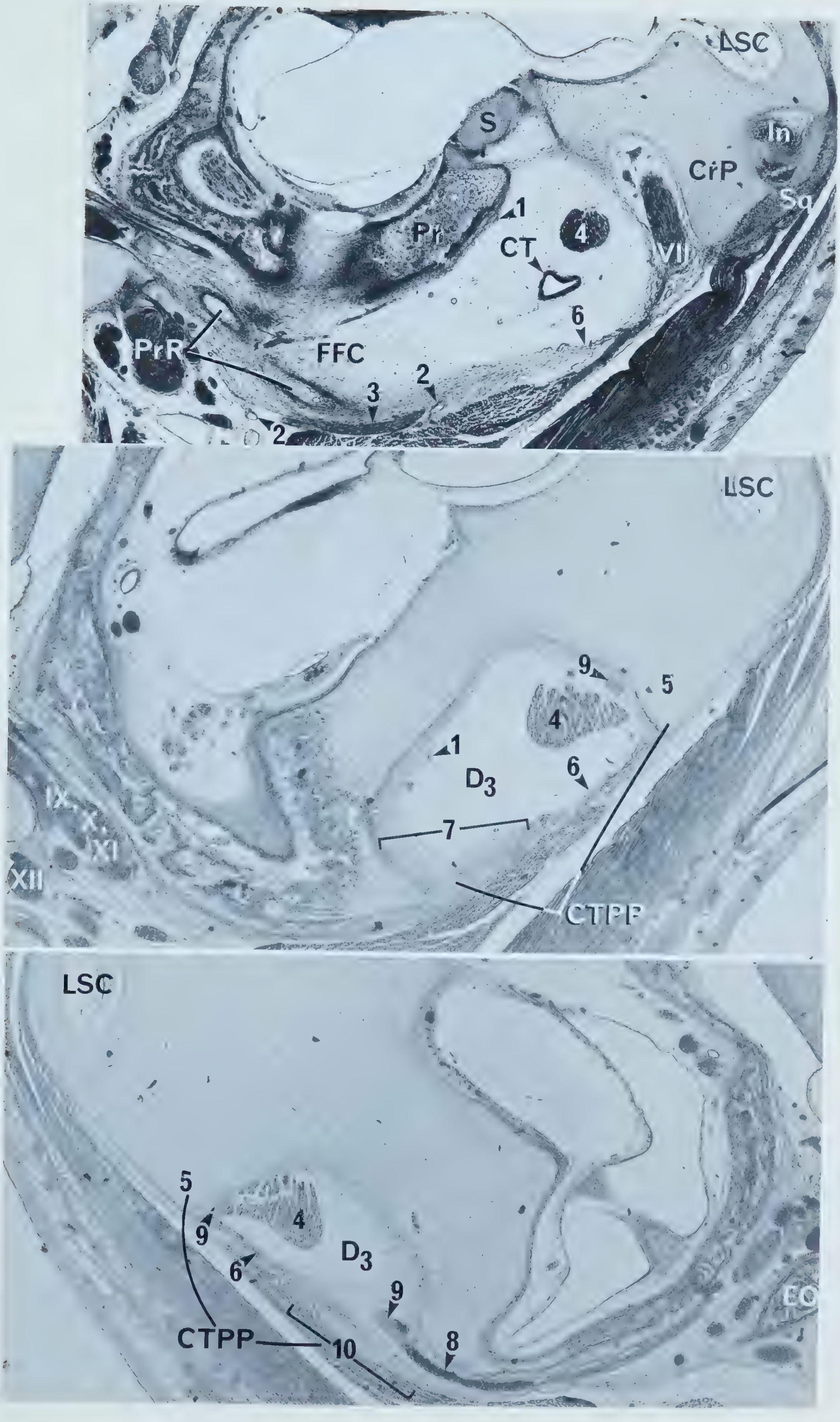
The processus recessus *per se* terminates on the anteroventral margin of the pars canalicularis, but the medial section of the caudal tympanic process of the petrosal continues somewhat further posteriorly (7). The posterior continuation of the crista parotica serves as the lateral section of the caudal tympanic process (5).

For key to numbered structures, see fig. II-15.

FIG. II-17 *M. murinus* MPIH 1964/41 (fetus); s. 1080, cross-section, right side; Azan; x 52.

The medial section of the caudal tympanic process of the petrosal (7) ends at the joint foramen for the auricular ramus of the vagus n. and the tympanic n. The posterior section of the caudal tympanic process (10) covers the extreme posterior part of the presumptive tympanic cavity, behind the level of this slide. Only its anterior margin is seen here.

For key to numbered structures, see fig. II-15.


LSC
S
In
CrP
Sq
1
Pr
CT
4
VII
6
PrR
FFC
2
3
2
LSC
9
5
4
1
D_3
6
IX
X
XI
XII
7
CTPP
LSC
5
9
4
D_3
6
9
CTPP
10
8

521

FIG. II-18 *M. murinus* MPIH 1962/57 (fetus); s. 88/1/1/ cross-section, left side; Azan; x 90.

Anastomosis of promontorial and anterior carotid aa.

1, nerves of the pterygoid canal; 2, promontorial a. joining anterior carotid a.; 3, anterior carotid a.; 4, cavernous sinus; 5, petro-occipital sinus; 6, alicochlear commissure.

FIG. II-19 *M. murinus* MPIH 1962/57 (fetus); s. 91/2/3, cross-section, left side; Azan; x 43.

Anterior pole of promontory.

1, promontorial a. and internal carotid n.; 2, anterior carotid a.; 3, petrosquamous sinus in postglenoid foramen; 4, alicochlear commissure; 5, lesser petrosal n.; 6, chorda tympani.


6
V
2
1
4
3
CAT
5
CT
E

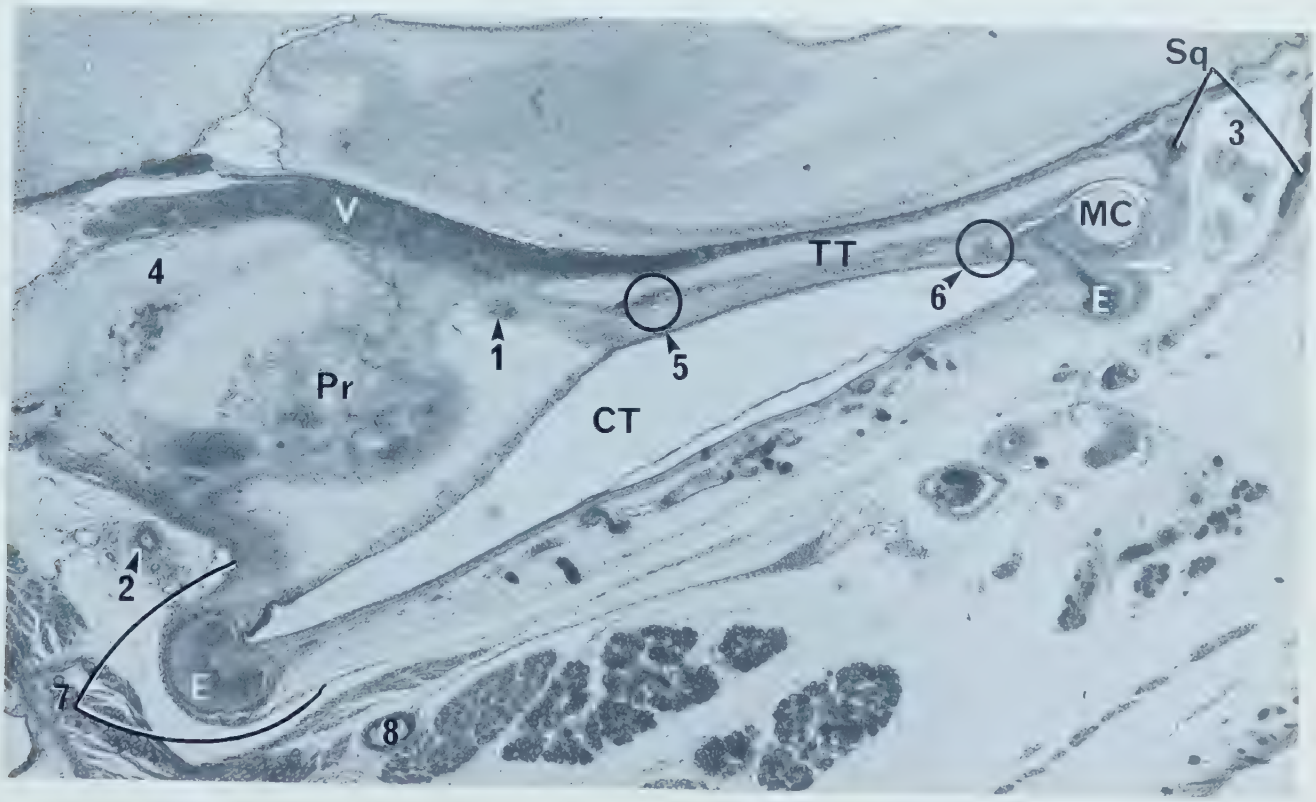

Sq
3
V
MC
4
TT
6
E
1
5
Pr
CT
2
E
7
8

FIG. II-20 *M. murinus* MPIH 1962/57 (fetus); s. 121/2/3, cross-section, left side; Azan; x 43.

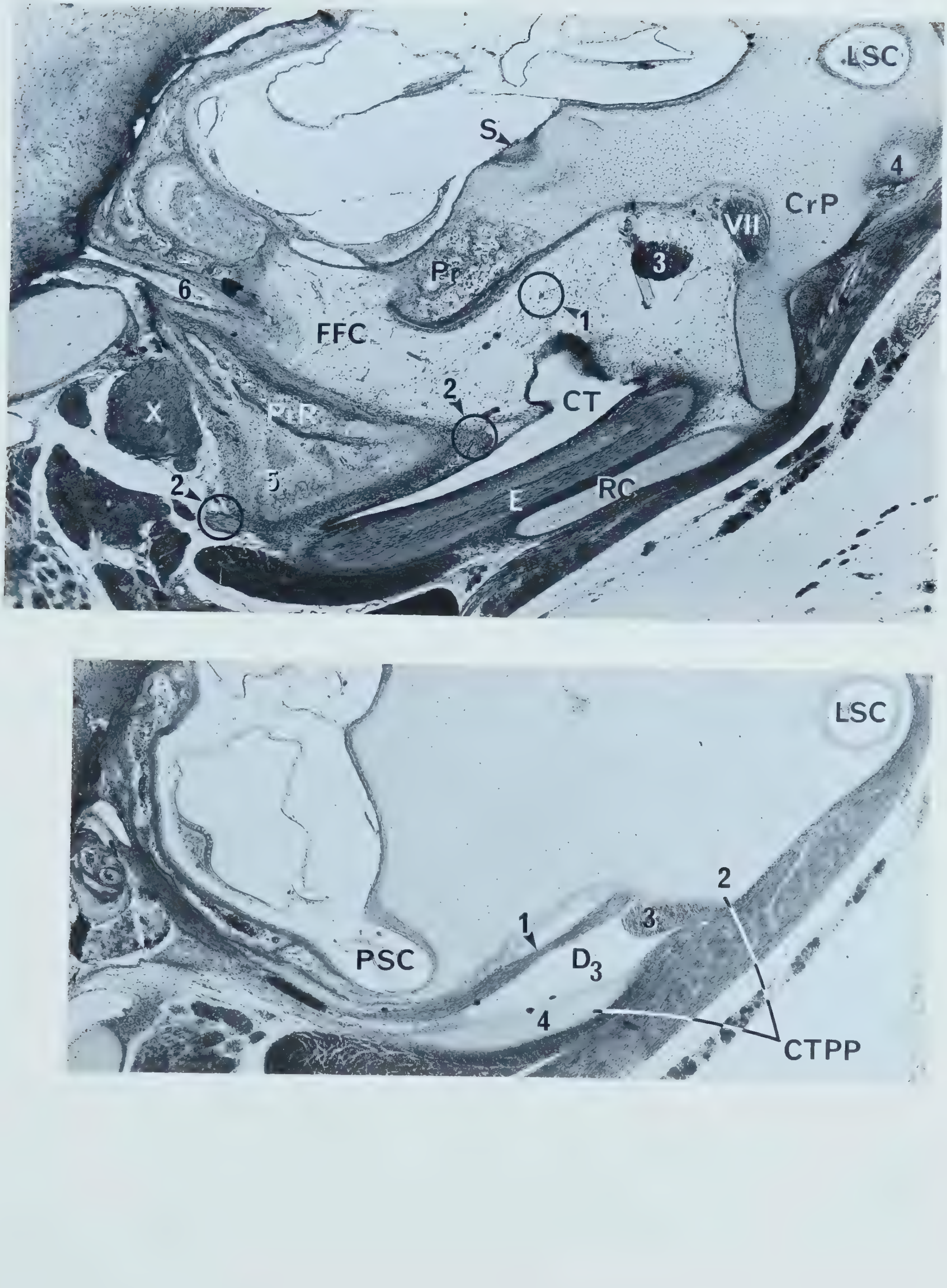
The processus recessus, or medial wall of the apertura fossulae fenestrae cochleae, is bony except for its lateral margin. The trabeculae arising from the ventral surface of the processus are part of the cave-like formation which marks the structural termination of the rostral tympanic process of the petrosal. From this stage onward, the rostral and caudal tympanic processes of the petrosal form a single, continuous rampart, the petrosal plate.

1, tympanic n.; 2, internal carotid a. and n.; 3, stapedius m.; 4, posterior crus of incus; 5, end of RTPP on processus recessus; 6, perilymphatic duct.

FIG. II-21 *M. murinus* MPIH 1962/57 (fetus); s. 129/1/1, cross-section, left side; Azan; x 43.

Origin of stapedius m. and posterior and lateral sections of caudal tympanic process of petrosal.

1, auricular ramus of vagus entering rear of tympanic cavity; 2, posterior continuation of crista parotica (lateral section of CTPP); 3, stapedius m.; 4, posterior section of CTPP.



LSC
S
4
CrP
VII
3
Pr
6
1
FFC
2
CT
X
5
2
RC
E
LSC
2
3
1
PSC
D_3
4
CTPP

FIG. II-22 M. murinus MPIH 1964/43 (fetus); s. 1048, cross-section, left side; Azan; x 30.

Anterior part of petrosal plate. Note remnant of piriform fenestra (3).

1, greater petrosal n.; 2, promontorial a. and internal carotid n.; 3, remnant of piriform fenestra; 4, chorda tympani; 5, stylohyal center (in Reichert's cartilage); 6, lesser petrosal n.; 7, anterior carotid a.; 8, alicochlear commissure; 9, auricular cartilage.

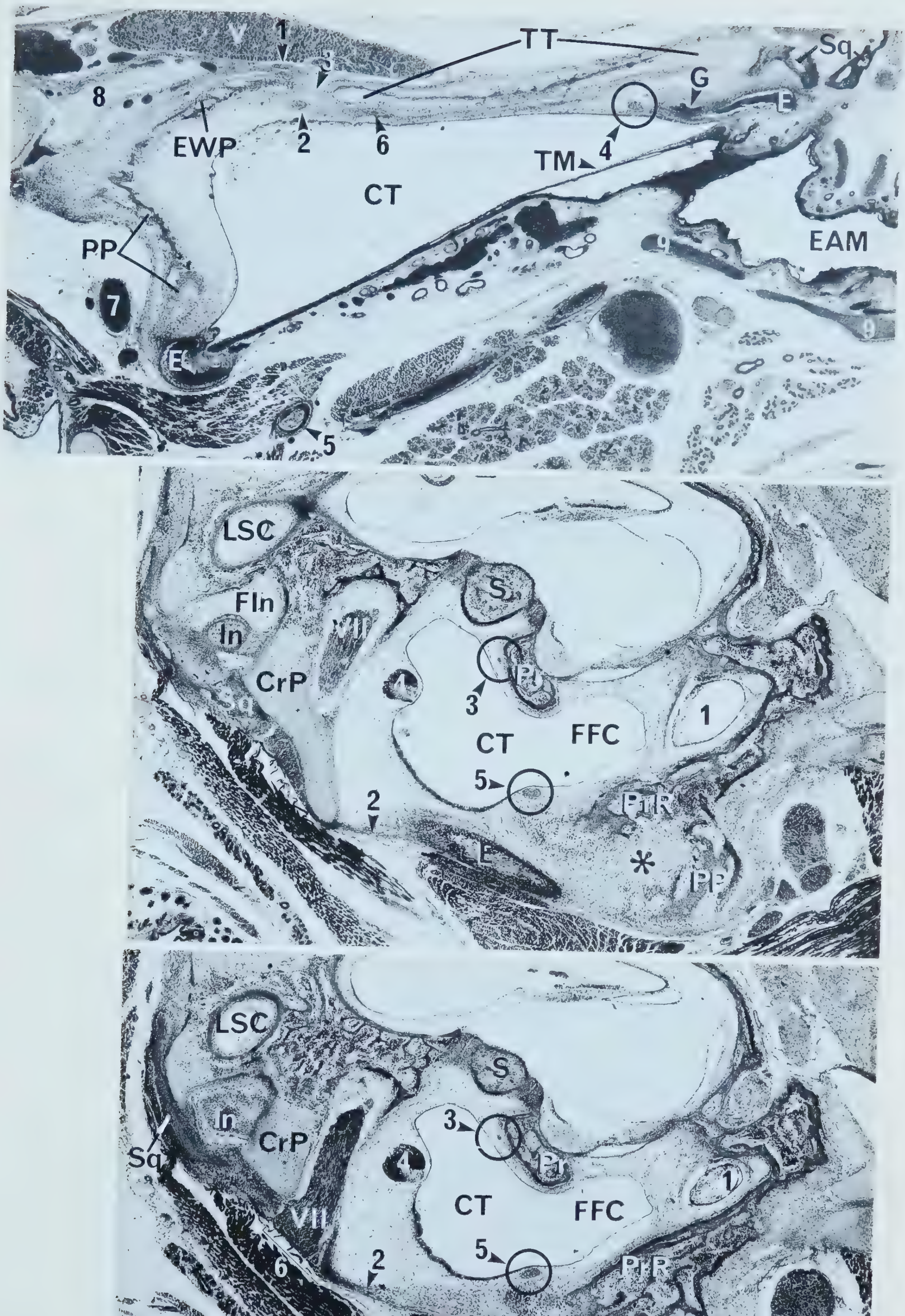
FIG. II-23 M. murinus MPIH 1964/43 (fetus); s. 1320, cross-section, right side; Azan; x 31.

Posterior part of petrosal plate. This and the following figure depict the cave-like formation (asterisk) which marks the structural boundary between the original subdivisions of the petrosal plate (rostral and caudal tympanic processes of the petrosal).

1, perilymphatic duct; 2, FMTC; 3, tympanic n.; 4, stapedius m.; 5, internal carotid a. and n.; 6, foramen stylomastoideum primitivum.

FIG. II-24 M. murinus MPIH 1964/43 (fetus); s. 1328, cross-section, right side; Azan; x 31.

See legend of fig. II-23.



V
1
3
TT
Sq
8
G
E
EWP
2
6
4
TM
CT
PP
EAM
9
7
E
5
LSC
S
FIn
In
VII
CrP
Pt
3
4
Sq
1
CT
FFC
5
PtR
2
E
*
PP
LSC
S
In
CrP
3
Pt
Sq
4
1
CT
FFC
VII
5
6
2
PtR
PP

FIG. II-25 M. murinus MPIH 1964/42 (fetus); s. 1010, cröss-section, right side; Azan; x 30.

Anterior end of presumptive tympanic cavity.

1, petro-occipital sinus; 2, anterior carotid a.; 3, alicochlear commissure (degenerating); 4, anteromedial process of bulla; 5, floor of tubal canal (formed by petrosal plate).

FIG. II-26 M. murinus MPIH 1964/42 (fetus); s. 1020, cross-section, right side; Azan; x 225.

Secondary cartilage in ventral enlargement of petrosal plate. The arrows indicate the position of the fibrous membrane of the tympanic cavity. The brackets indicate the position of the bone-like tissue on the medial side of the ventral enlargement, while the black asterisk lies in the part of the enlargement which is composed of secondary cartilage. The white asterisks near the top of the figure indicate the position of chondroclast-like cells.

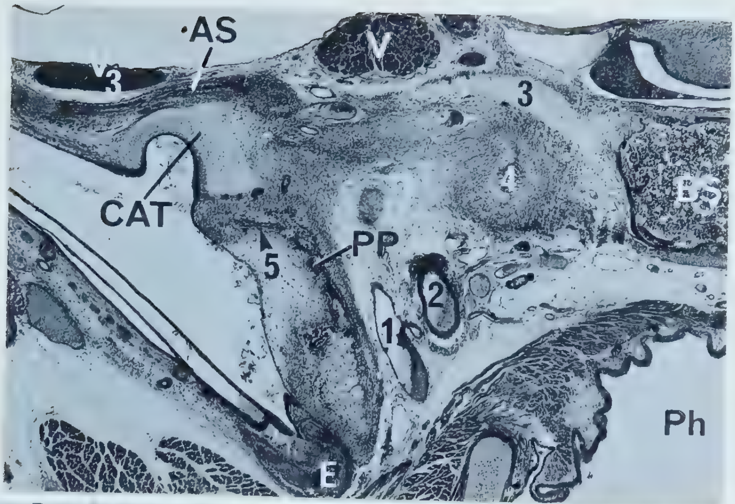
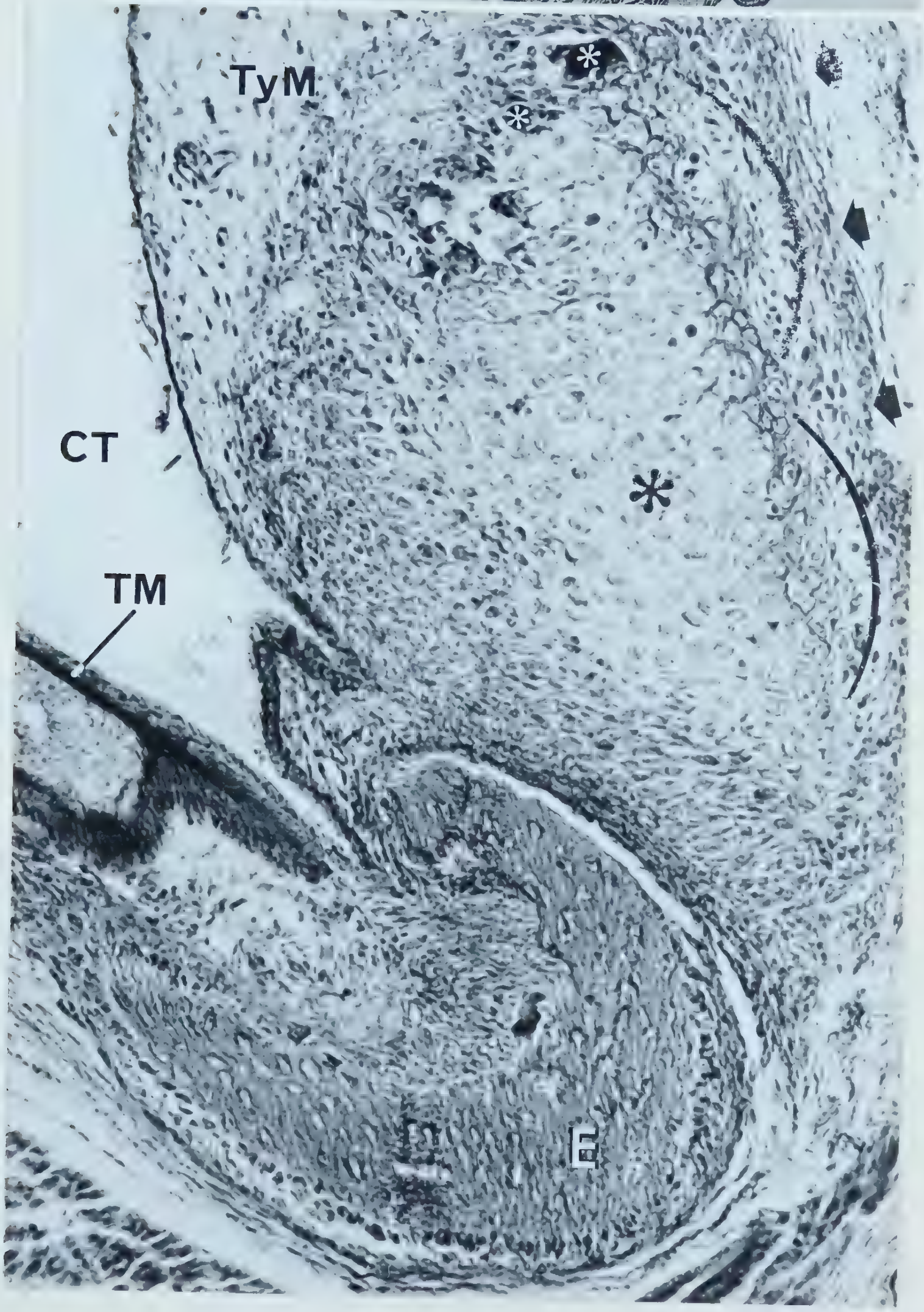

AS
V3
V
3
CAT
4
BS
5
PP
2
1
Ph
E

TyM
CT
TM
E

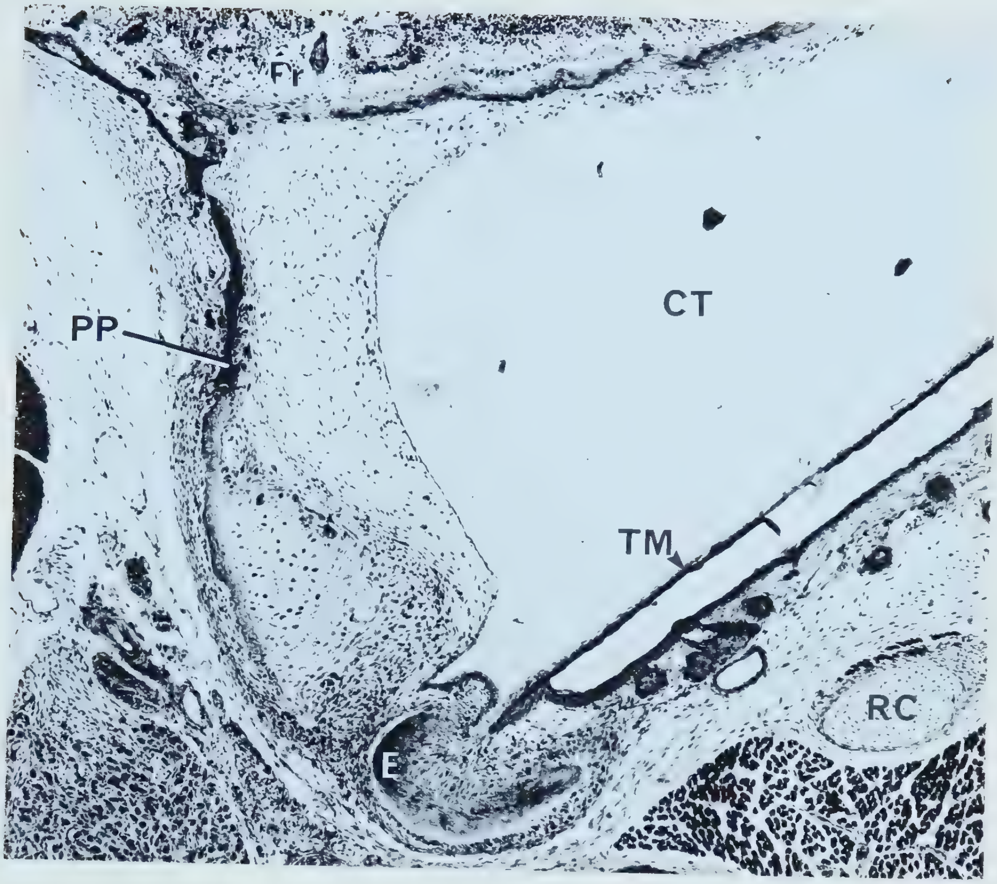
FIG. II-27 *M. murinus* MPIH 1964/42 (fetus); s. 1126, cross-section, left side; Heidenhain-Woelke; x 85.

With this stain, bone and cartilage cells and bone matrix stain black, while cartilage matrix remains virtually colorless. The secondary cartilage of the petrosal plate is less organized in appearance than the (primary) cartilage of Reichert's cartilage (lower right).

FIG. II-28 *M. murinus* MPIH 1964/42 (fetus); s. 1282, cross-section, left side; hematoxylin and eosin; x 43.

The petrosal plate now forms a complete floor beneath the posterior part of the tympanic cavity. (Cf. figs. II-20, II-23, and II-24).

1, internal carotid a.; 2, tympanic n. (tympanic canaliculus separate from mastoid canaliculus in this specimen); 3, perilymphatic duct; 4, internal carotid n.; 5, foramen stylomastoideum definitivum.


Fr
PP
CT
TM
RC
E

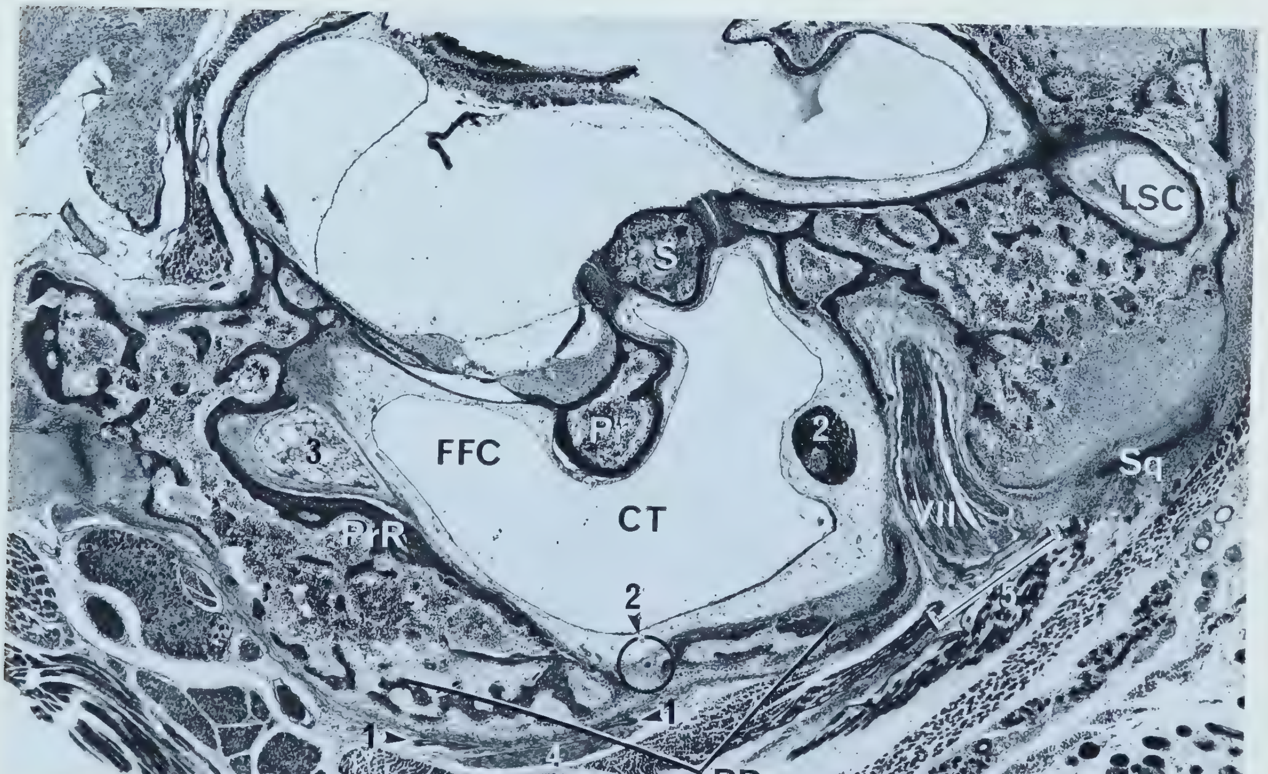

LSC
S
P
FFC
3
2
Sq
CT
PtR
VII
2
1
1
PP

FIG. II-29 _M. murinus_ MPIH 1964/42 (fetus); s. 1240, cross-section, right side; Azan; x 31.

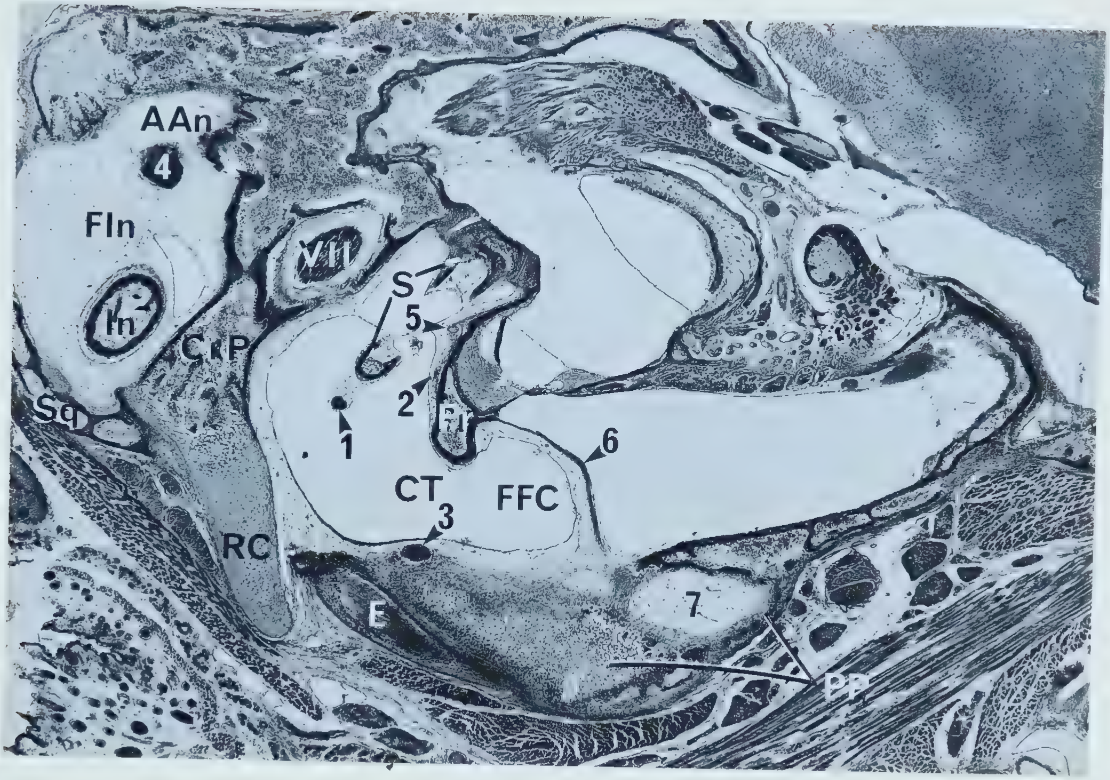
The mastoid cavity is represented by its aditus alone, despite the advanced age of this specimen.

1, tendon of stapedius m.; 2, tympanic n.; 3, internal carotid a. and n.; 4, wall of lateral semicircular canal projecting beneath aditus ad antrum; 5, stapedial a.; 6, secondary tympanic membrane; 7, cave-like formation.

FIG. II-30 _M. murinus_ MPIH 1964/42 (fetus); s. 1320, cross-section, left side; Azan; x 43.

The floor of the posterior part of the tympanic cavity (D_3) is bony, and the origin of the stapedius m. is situated entirely within the cavity itself.

1, ramus auricularis vagi; 2, vein in mastoid canaliculus; 3, posterior continuation of crista parotica (lateral section of CTPP); 4, stapedius m.


AAn
4
Fln
In
VII
S
5
CrP
Sq
1
2
Fl
6
CT
3
FFC
RC
E
7
PP


LSC
3
D3
1
4
IX
X
XI
2
PP

FIG. II-31 _Propithecus_ sp. AI 210/211 (fetus); s. 135/2, cross-section, right side; Azan; x 20.

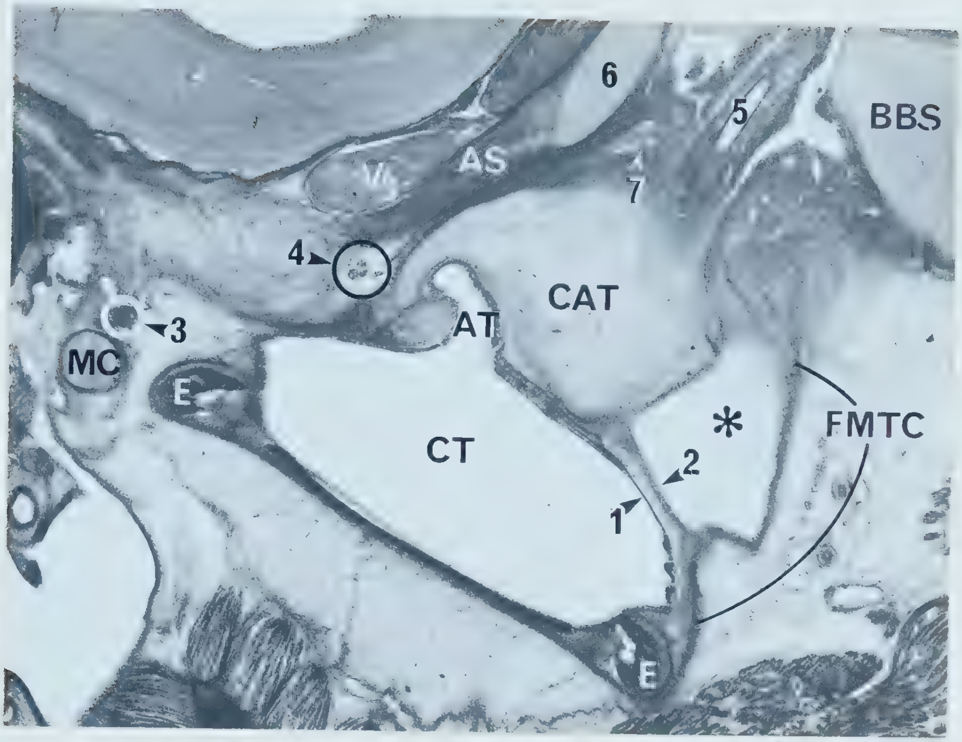
Anterior end of presumptive tympanic cavity. Note the small diverticulum created beneath the cartilage of the auditory tube by the fibrous membrane.

1, epithelium of tunica mucosa (developing); 2, extension of fibrous membrane into tympanic cavity; 3, chorda tympani; 4, lesser petrosal n.; 5, promontorial a. in foramen caroticum primitivum; 6, alicochlear commissure; 7, nerves of the pterygoid canal.

FIG. II-32 _Propithecus_ sp. AI 210/211 (fetus); s. 204/2, cross-section, right side (sides rev.); Azan; x 26.

The cartilaginous caudal tympanic process of the petrosal resembles that of young _M. murinus_ in all essential details except for being somewhat larger (cf. fig. II-21).

1, auricular ramus of the vagus; 2, stapedius m.


6
5
BBS
V
AS
7
4
3
CAT
AT
MC
E
CT
*
FMTC
2
1
E


LSC
EO
IX,
X,
XI
2
1
CTPP

FIG. II-33 *L. catta* MPIH 1964/28 (10 days old); s. 2090, cross-section, right side (sides rev.); Azan; x 19.

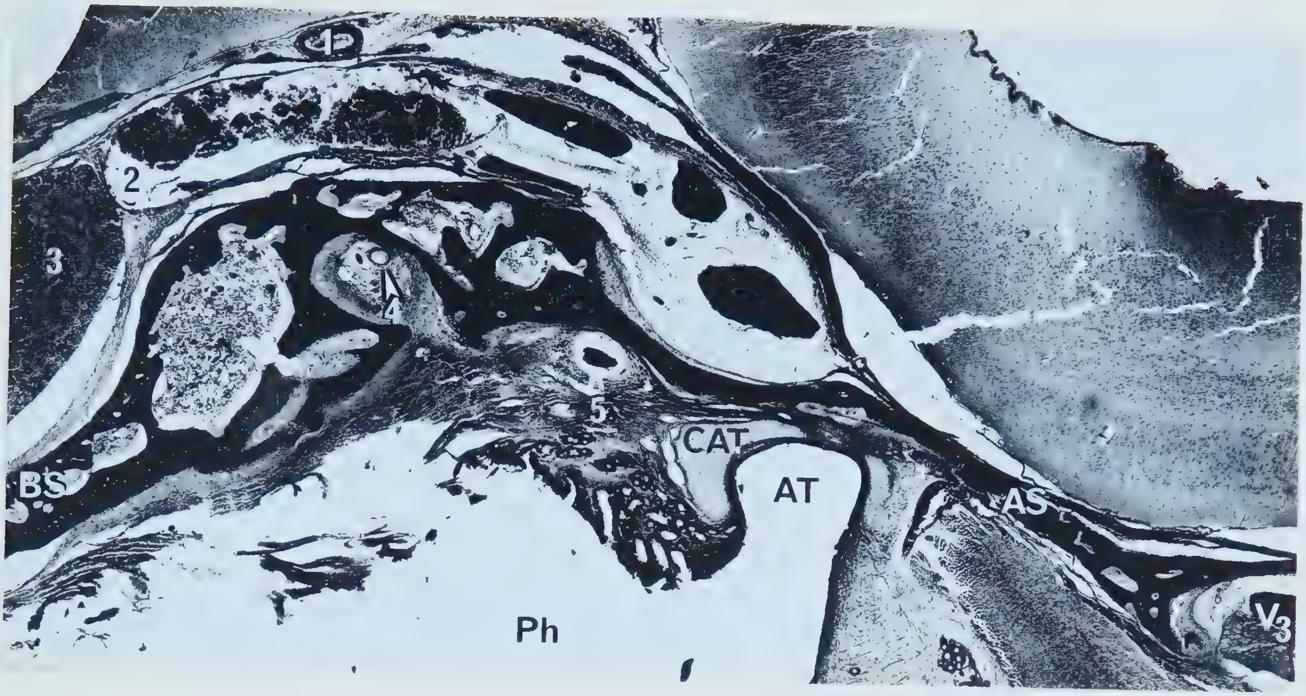
Passage of promontorial a. through anterior carotid canal.

1, circulus arteriosus; 2, cavernous sinus; 3, hypophysis; 4, promontorial a. in true anterior carotid canal; 5, nerves of pterygoid canal.

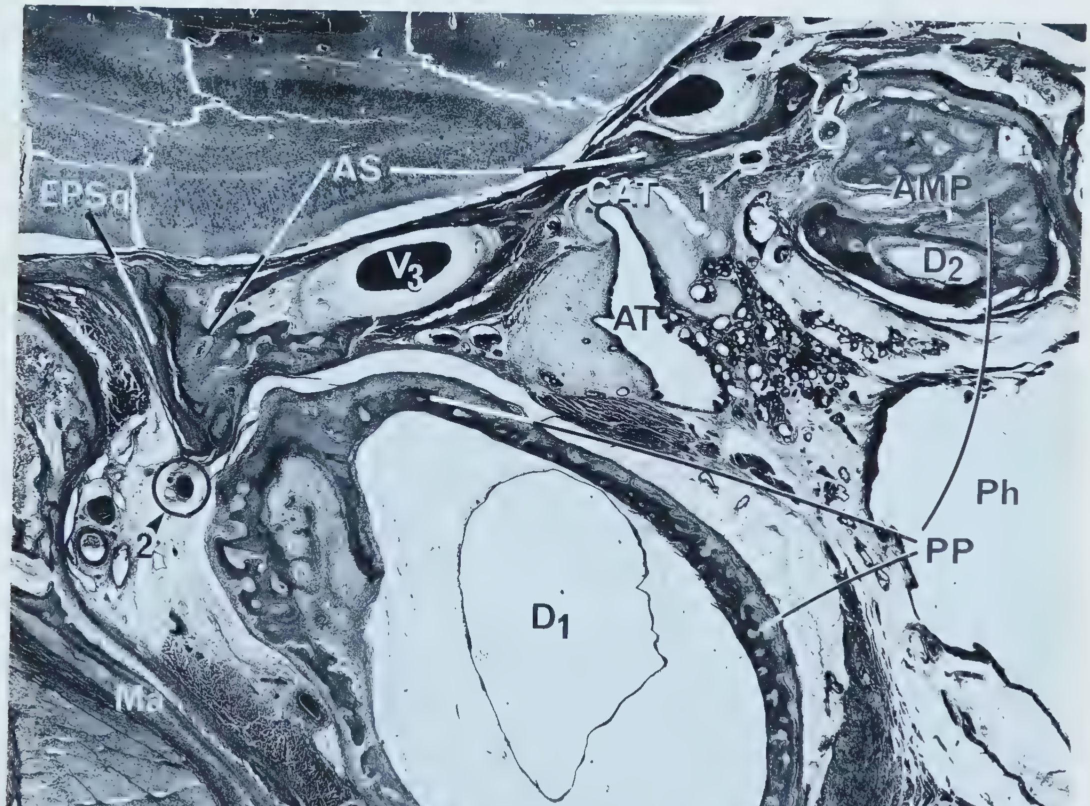
FIG. II-34 *L. catta* MPIH 1964/28 (10 days old); s. 2160, cross-section, right side; Azan; x 19.

Anterior wall of bulla, cartilage of the auditory tube, and anteromedial process. The promontorial a. passes between the cartilage of the tube and the anteromedial process in order to reach its canal (see fig. II-33).

1, nerves of pterygoid canal; 2, chorda tympani; 3, promontorial a. (exposed adjacent to anteromedial process of bulla).



1
2
3
4
5
BS
CAT
AT
AS
Ph
V_3



EPSq
AS
CAT
1
3
AMP
D_2
V_3
AT
2
Ph
PP
D_1
Ma

FIG. II-35 L. catta MPIH 1964/28 (10 days old); s. 2550, cross-section, right side; Azan; x 19.

The hypotympanic sinus ends in a posterior diverticulum (part of D_2) which is bounded laterally by the carotid canal and posterior septum. The relations of the posterior septum to this diverticulum indicates that pneumatization splits the original caudal tympanic processes of the petrosal into inner (medial wall of bulla) and outer (posterior septum) tables. See also fig. II-3 for adult conditions.

1, chorda tympani; 2, tensor tympani; 3, internal carotid n.; 4, stapedial a. in its canal; 5, internal carotid a. in its canal; 6, posterior septum; 7, divisions of tympanic n.; 8, greater petrosal n.

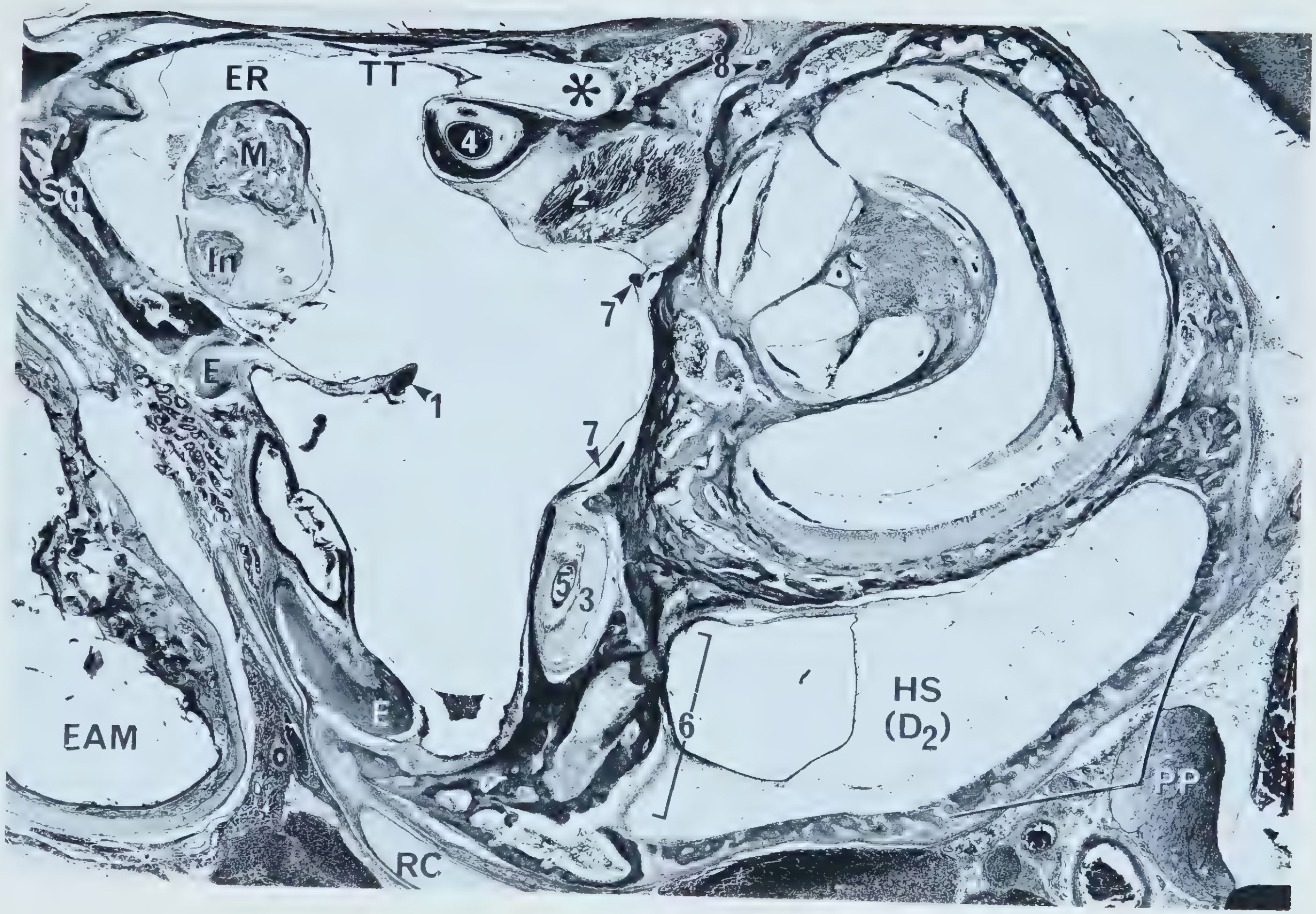
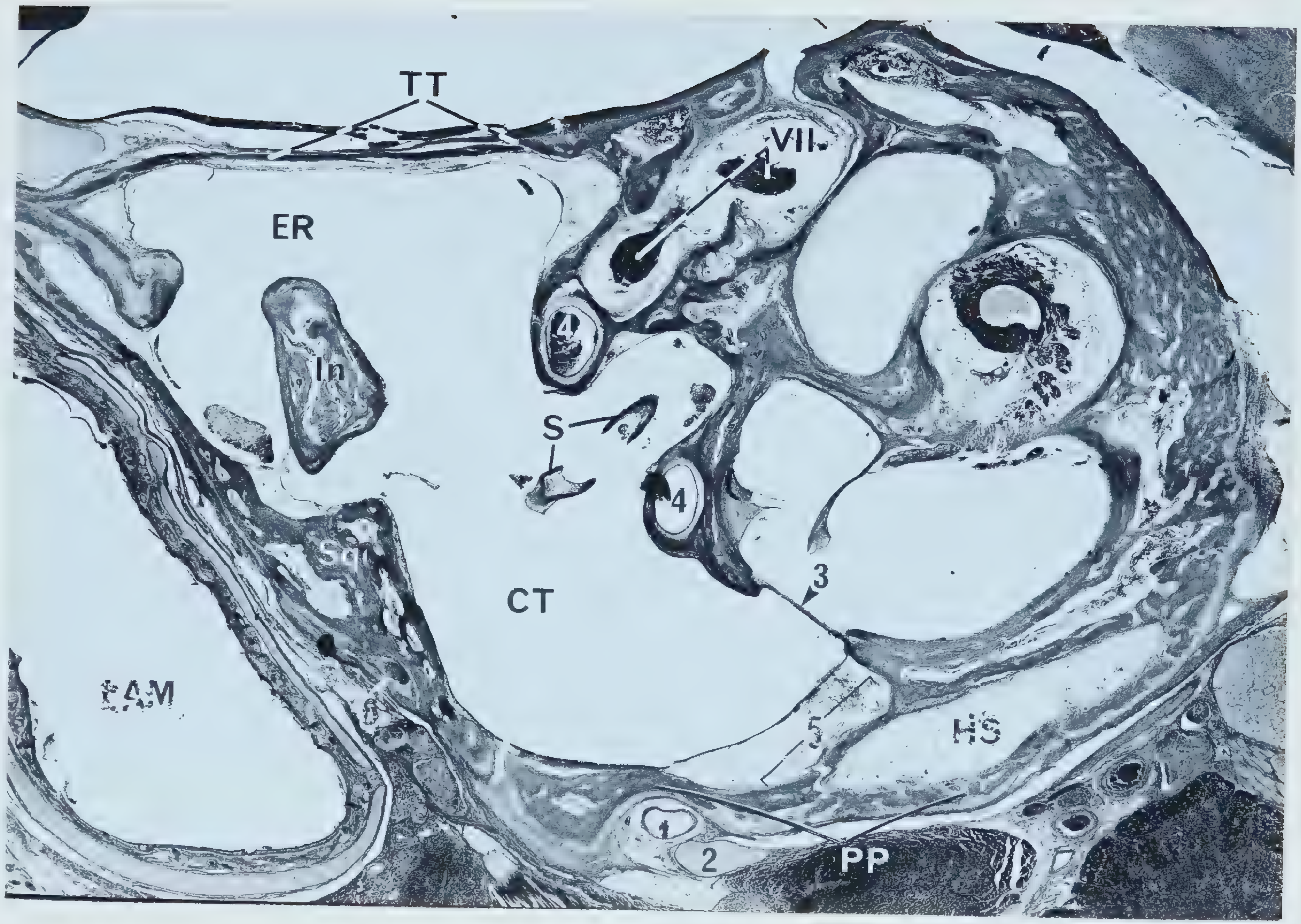

ER
TT
*
8
M
4
Sq
2
In
7
E
1
7
5
3
6
HS
(D_2)
EAM
E
PP
RC

FIG. II-36 *L. catta* MPIH 1964/28 (10 days old); s. 2625, cross-section, right side; Azan; x 19.

Terminal part of posterior diverticulum of hypotympanic sinus (D_2).

1, internal carotid a.; 2, internal carotid n.; 3, secondary tympanic membrane; 4, stapedial a.; 5, posterior septum; 6, chorda tympani in its canaliculus.


TT
VII
ER
In
4
S
4
3
Sq
CT
EAM
5
HS
1
2
PP

541

FIG. II-37 *L. catta* MPIH 1964/28 (10 days old); s. 2680, cross-section, right side; Azan; x 19.

Anterior end of mastoid cavity.

1, tendon of stapedius m.; 2, tympanic n. passing through tympanic canaliculus; 3, perilymphatic duct; 4, internal carotid a.

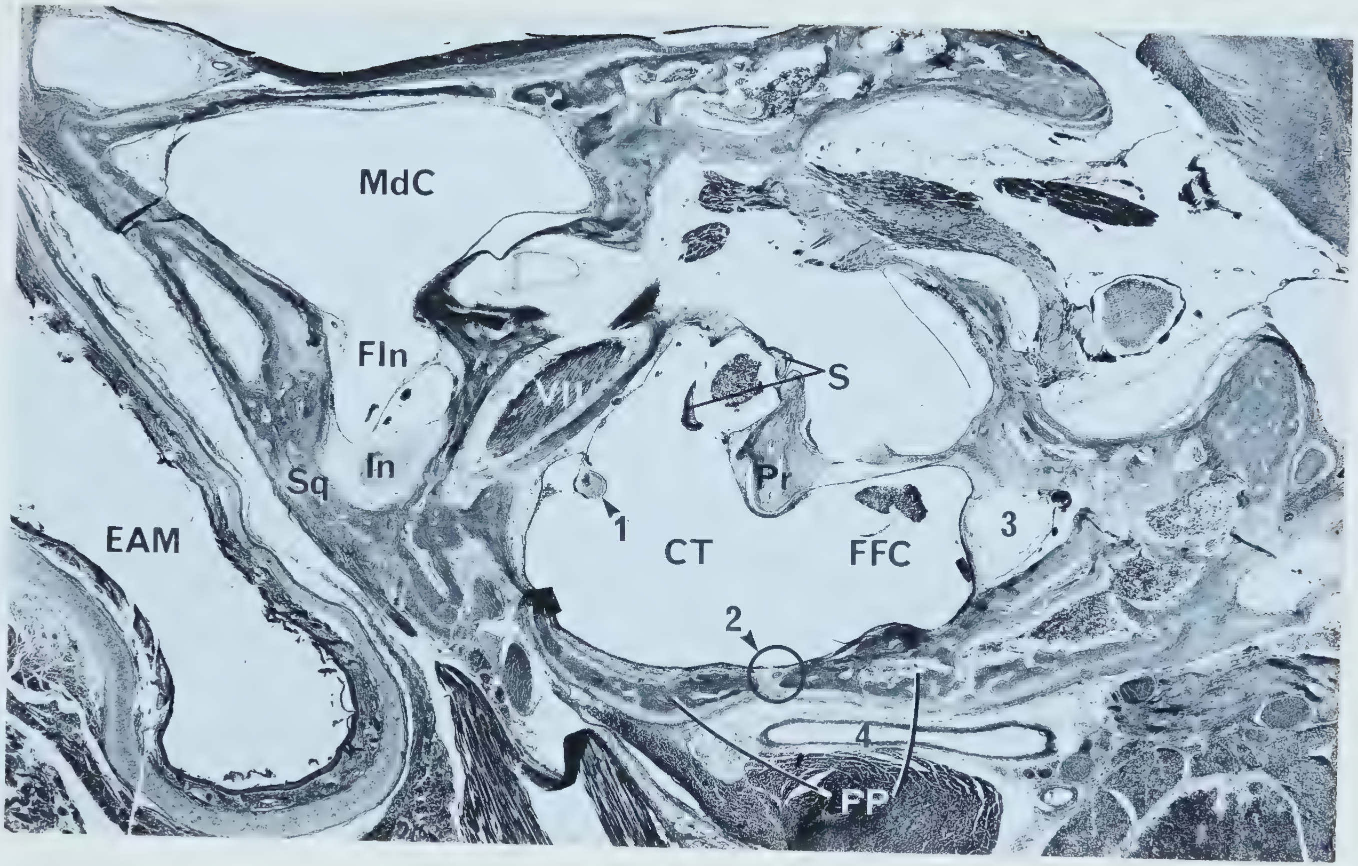

MdC
FIn
In
Sq
EAM
VII
S
Pr
1
CT
FFC
3
2
4
PP

FIG. II-38 *L. catta* MPIH 1964/28 (10 days old); s. 2735, cross-section, left side; Azan; x 19.

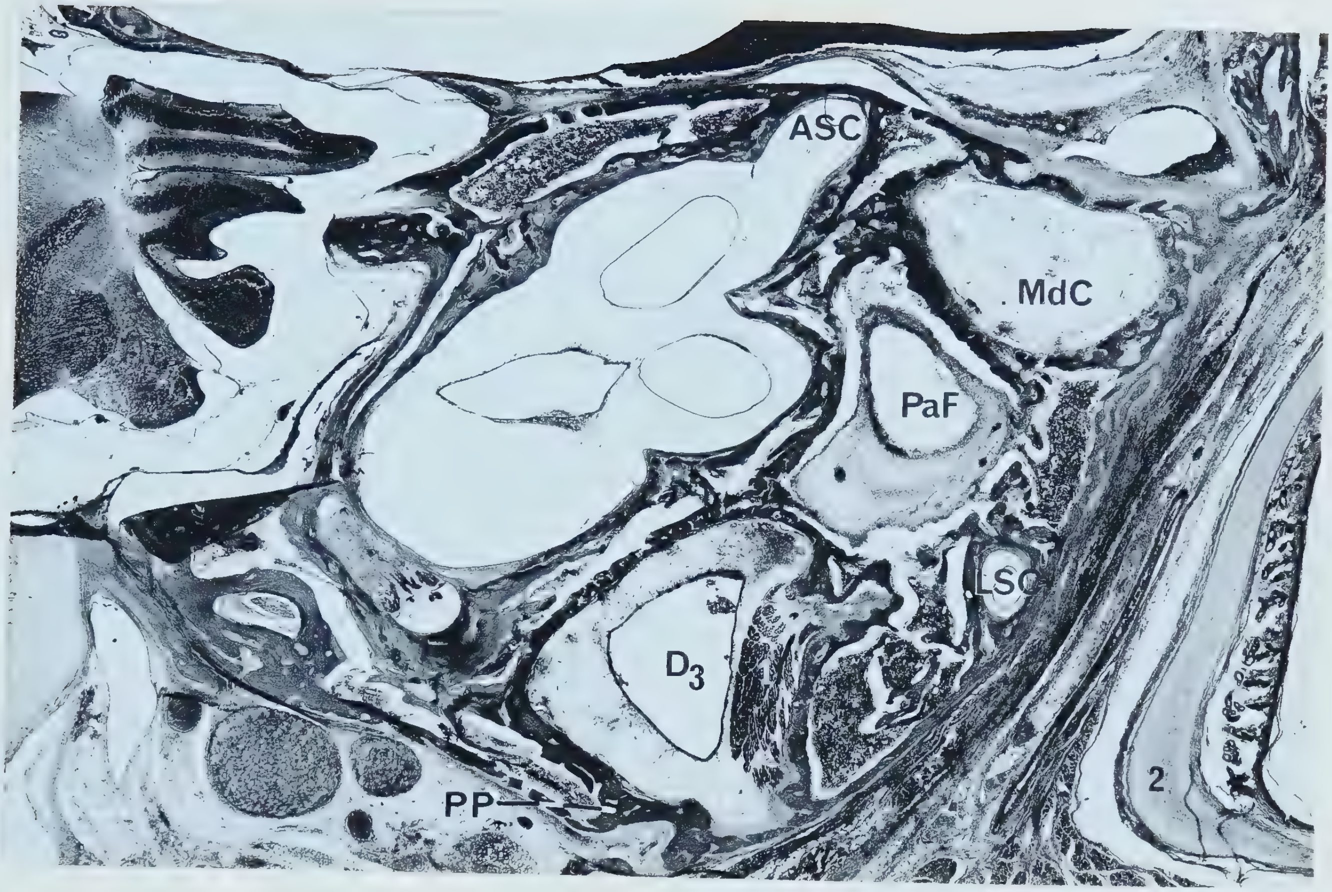
Posterior end of mastoid cavity.

1, stapedius m.; 2, auricular cartilage.

FIG. II-39 *L. catta* MPIH 1964/28 (10 days old); s. 2550, cross-section, left side; Azan; x 18.5.

Dural branch of stapedial a.

1, dural branch of stapedial a.; 2, tensor tympani m.; 3, greater petrosal n.; 4, stapedial a. (main stem).


ASC
MdC
PaF
LSC
D_3
PP
2

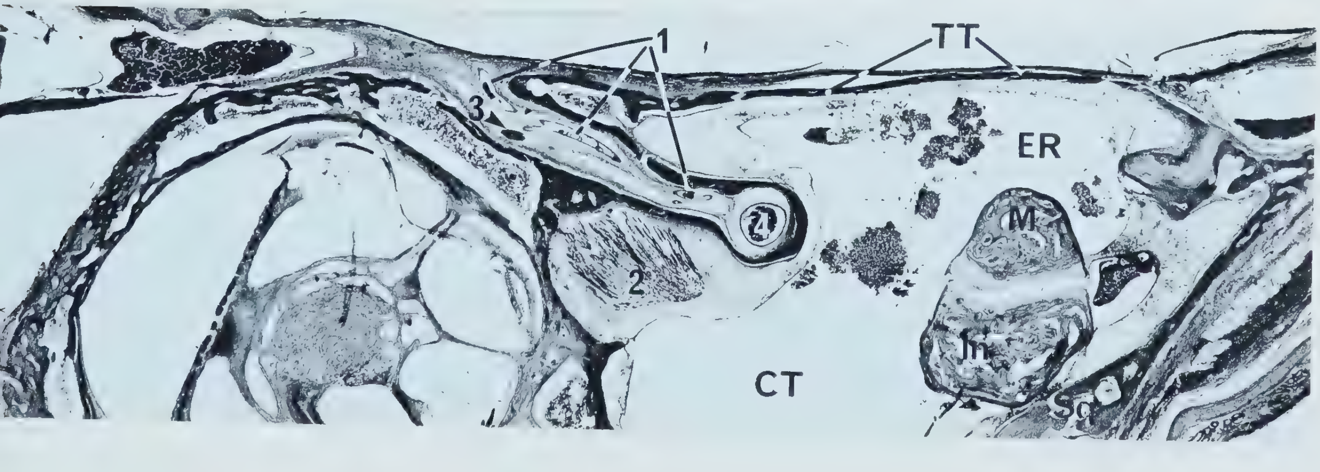

1
TT
3
ER
M
2
In
CT
Sq

FIG. II-40 Carotid circulation in strepsirhines (diagrammatic); a = *Lemur catta*, b = *Microcebus murinus*, c = *Galago senegalensis*. Diagrams a and c after BUGGE (1974); diagram b is based on the specimens of *M. murinus* used in this study. Method of identification of vessels and anastomoses is that of BUGGE (1974).

ap	-	a. auricularis posterior
c	-	a. ciliaris
cc	-	a. carotis communis
ce	-	a. carotis externa (proximal part)
ce'	-	a. carotis externa (distal part)
ci	-	a. carotis interna
ci'	-	apparent internal carotid (anterior carotid)
cp	-	a. communicans posterior
e	-	a. ethmoidalis
f	-	a. frontalis
fa	-	a. facialis
l	-	a. lacrimalis
li	-	a. lingualis
mm	-	a. meningea media
oi	-	a. ophthalmica interna
oi'	-	"internal" ophthalmic a.
ri	-	ramus infracorbitalis
rm	-	ramus mandibularis
rs	-	ramus supraorbitalis
st	-	a. stapedia
st'	-	distal part of stapedial artery stem
tf	-	a. transversa faciei
ts	-	a. temporalis superficialis
a1	-	anastomosis between orbital arteries (1,f,e) from the supraorbital branch (rs) and the ciliary artery (c) from the circulus arteriosus (circle of Willis)
a1'	-	anastomosis between common stem of frontal (f) and ethmoidal (e) arteries and the circulus arteriosus
a3	-	anastomosis between the distal end of the external carotid (ce') and the proximal part of the mandibular branch (rm).

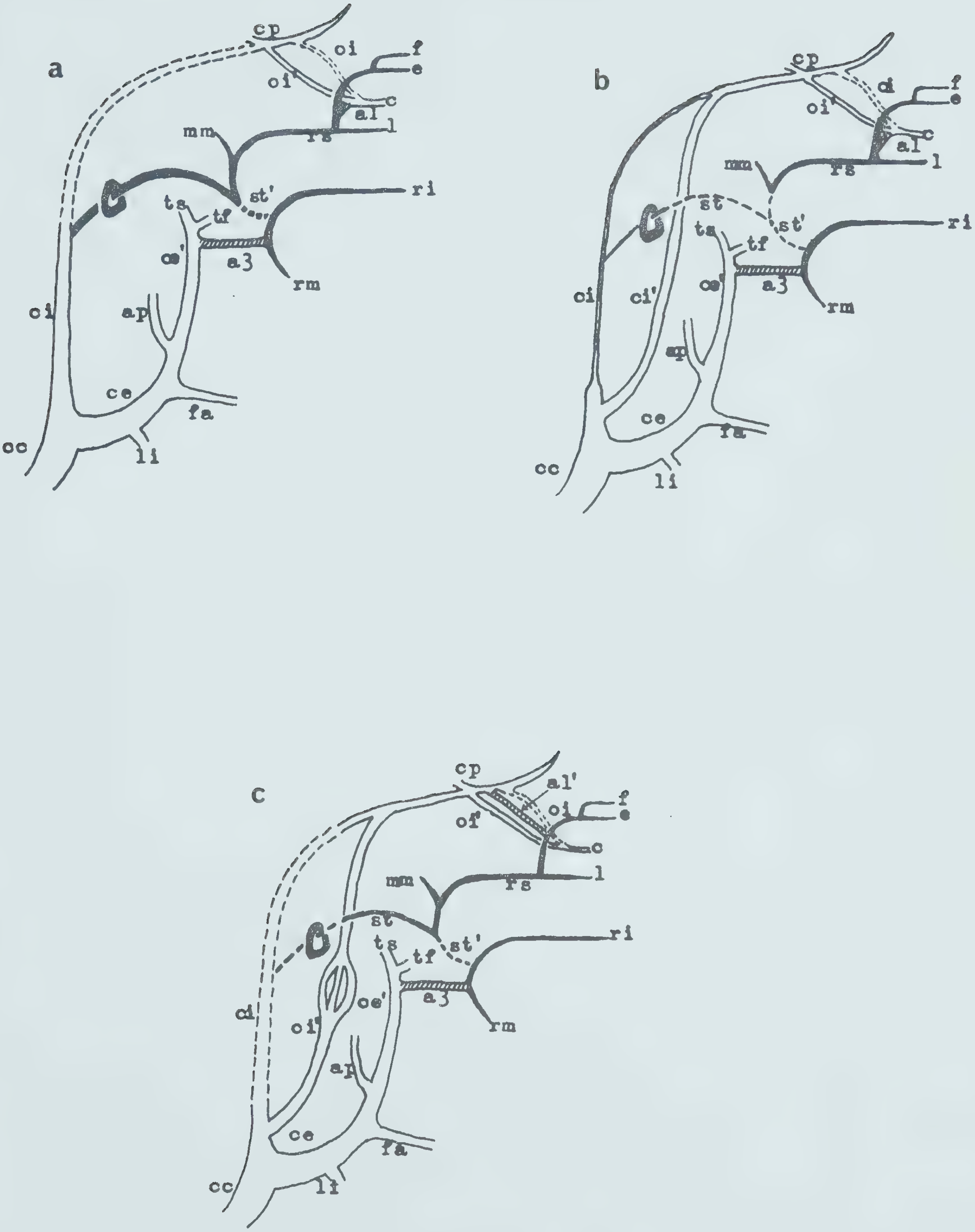

a
cp
oi
f
e
oi'
c
al
mm
rs
l
st'
ri
ts
tf
ce'
a3
rm
ci
ap
ce
fa
cc
li
b
c
al'
st
oi'

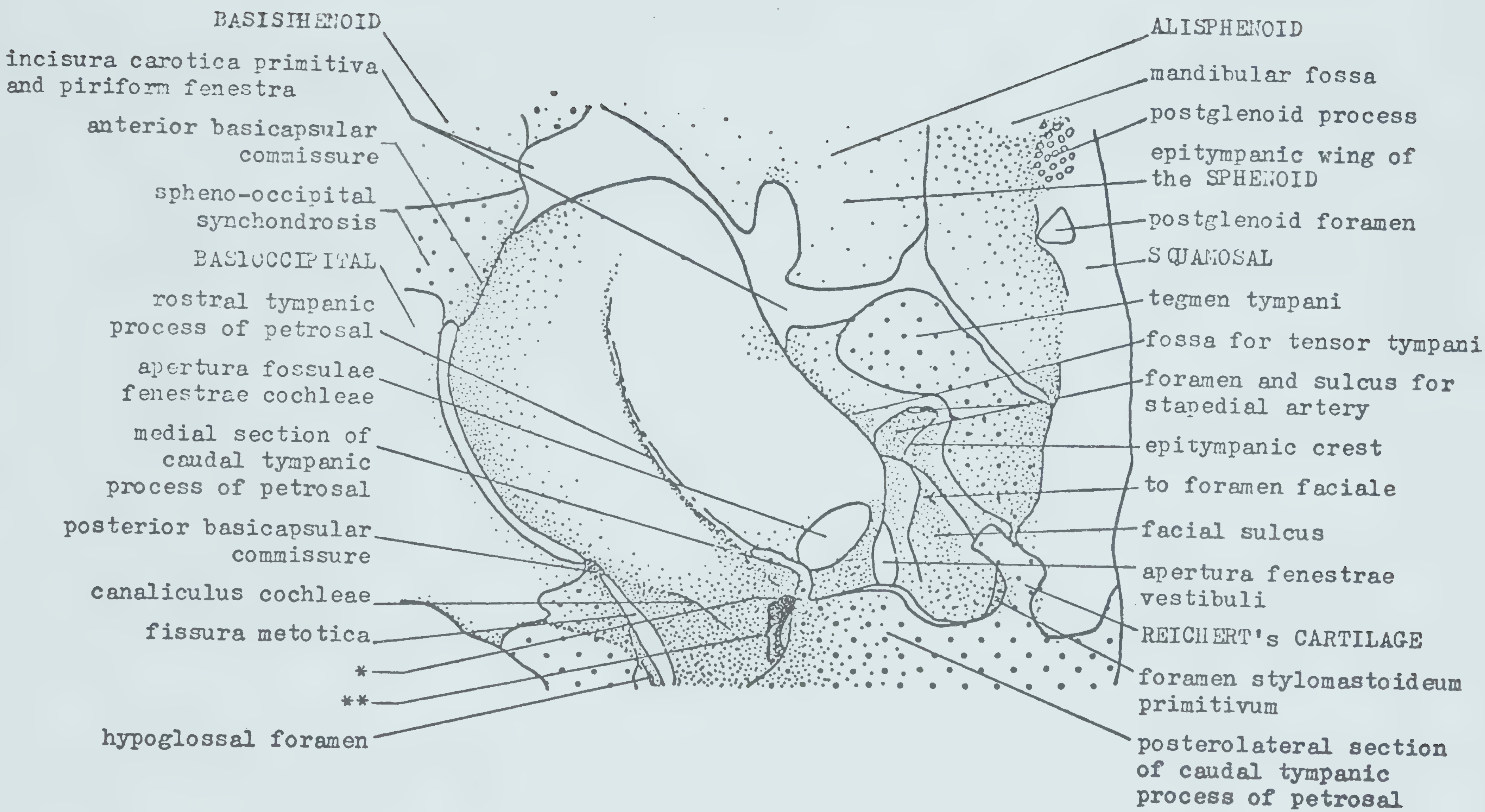
FIG. III-1 *G. demidovii* MPIH 120 (fetus). Reconstruction of left auditory region and associated structures, ca. x 20. See fig. II-1 for shading conventions.

a. General anatomy.

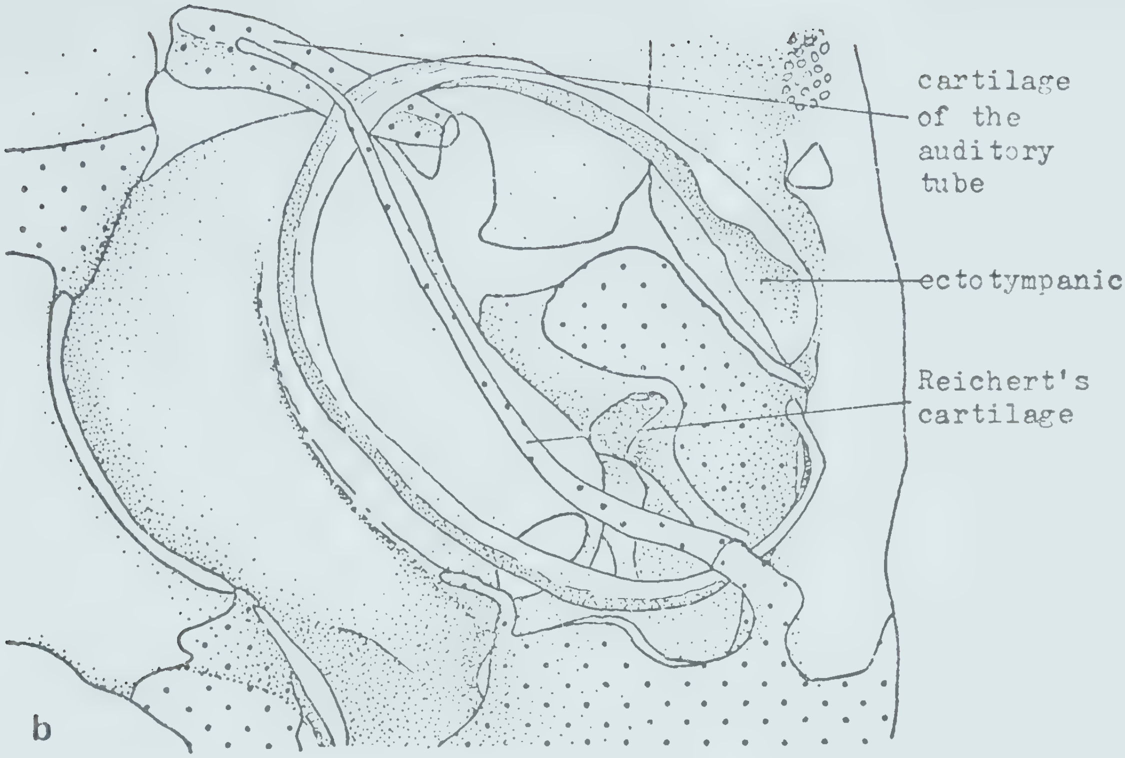
b. Ectotympanic, Reichert's cartilage and cartilage of the auditory tube *in situ*.

c. Routes of arteries and nerves.

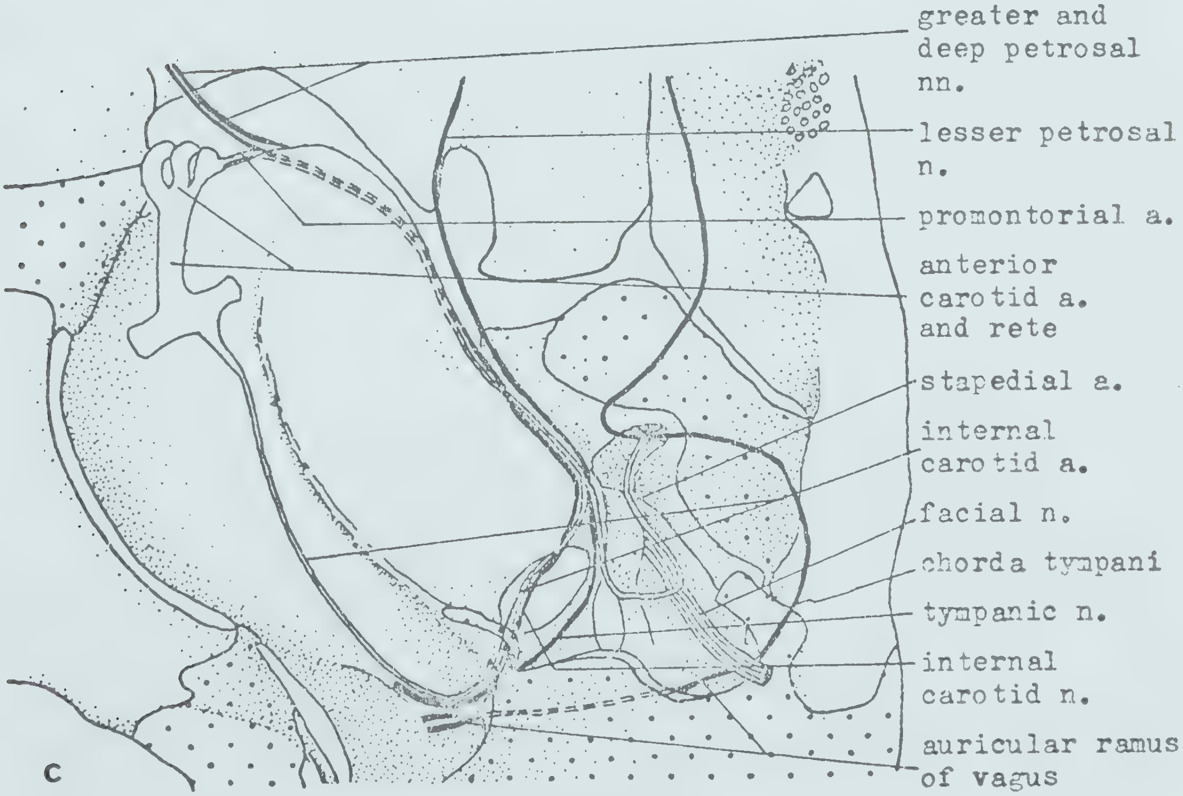
The developing petrosal plate strongly accords with that of fetal *M. murinus* (fig. II-1) in respect of its origin, positioning and structure. ** - cartilaginous bridge joining medial and posterolateral sections of CTPP; ** - joint foramen in CTPP for internal carotid artery and various nerves.


BASISPHENOID
incisura carotica primitiva and piriform fenestra
anterior basicapsular commissure
spheno-occipital synchondrosis
BASIOCCIPITAL
rostral tympanic process of petrosal
apertura fossulae fenestrae cochleae
medial section of caudal tympanic process of petrosal
posterior basicapsular commissure
canaliculus cochleae
fissura metotica
*
**
hypoglossal foramen
ALISPHENOID
mandibular fossa
postglenoid process
epitympanic wing of the SPHENOID
postglenoid foramen
SQUAMOSAL
tegmen tympani
fossa for tensor tympani
foramen and sulcus for stapedial artery
epitympanic crest
to foramen faciale
facial sulcus
apertura fenestrae vestibuli
REICHERT's CARTILAGE
foramen stylomastoideum primitivum
posterolateral section of caudal tympanic process of petrosal

a


cartilage of the auditory tube
ectotympanic
Reichert's cartilage

b

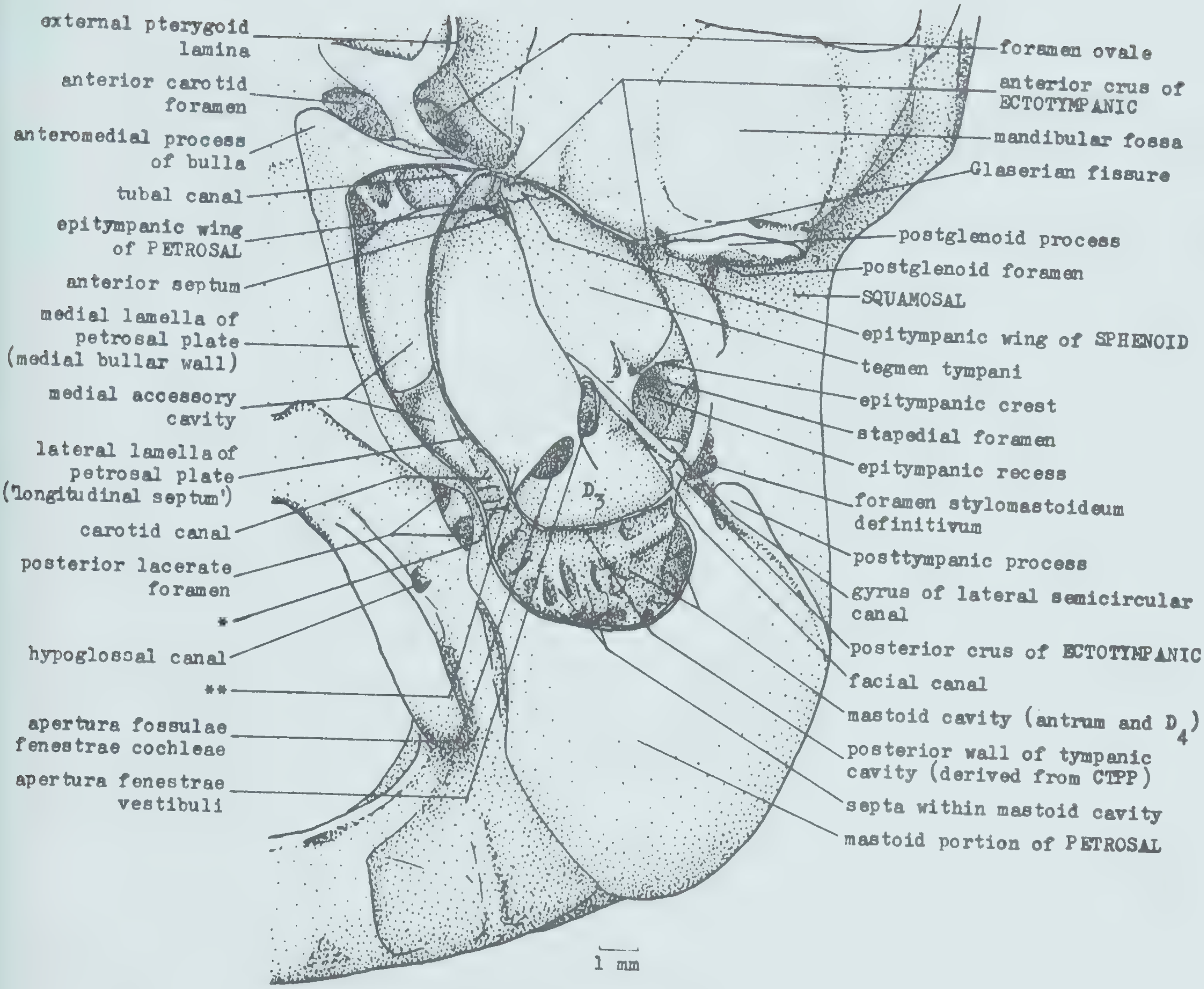

greater and deep petrosal nn.
lesser petrosal n.
promontorial a.
anterior carotid a. and rete
stapedial a.
internal carotid a.
facial n.
chorda tympani
tympanic n.
internal carotid n.
auricular ramus of vagus

c

FIG. III-2 G. senegalensis adult. General view of left auditory region, ventral aspect.

Most of the ventral part of the bulla (petrosal plate and ectotympanic) has been removed in order to expose the cavities of the middle ear. Of particular note is the medial accessory cavity, which is formed by the penetration of the supracochlear and mastoid cavities into the substance of the petrosal plate. The position of diverticulum D_3 is indicated. Since the hypotympanic sinus must be regarded as vestigial or absent, the equivalents of diverticula D_1 and D_2 (of lemurs) are not present in lorises (unless one regards the small fossa on either side of the true anterior septum as such).

*, joint canal for tympani n. and auricular ramus of the vagus,
**, small diverticulum formed within original medial section of the caudal tympanic process of the petrosal.



external pterygoid lamina
anterior carotid foramen
anteromedial process of bulla
tubal canal
epitympanic wing of PETROSAL
anterior septum
medial lamella of petrosal plate (medial bullar wall)
medial accessory cavity
lateral lamella of petrosal plate ('longitudinal septum')
carotid canal
posterior lacerate foramen
*
hypoglossal canal
**
apertura fossulae fenestrae cochleae
apertura fenestrae vestibuli
D_3
foramen ovale
anterior crus of ECTOTYMPANIC
mandibular fossa
Glaserian fissure
postglenoid process
postglenoid foramen
SQUAMOSAL
epitympanic wing of SPHENOID
tegmen tympani
epitympanic crest
stapedial foramen
epitympanic recess
foramen stylomastoideum definitivum
posttympanic process
gyrus of lateral semicircular canal
posterior crus of ECTOTYMPANIC
facial canal
mastoid cavity (antrum and D_4)
posterior wall of tympanic cavity (derived from CTPP)
septa within mastoid cavity
mastoid portion of PETROSAL
1 mm

FIG. III-3 G. demidovii MPIH 125 (fetus); s. 810, cross-section, Kluver-Barrera; x 27.

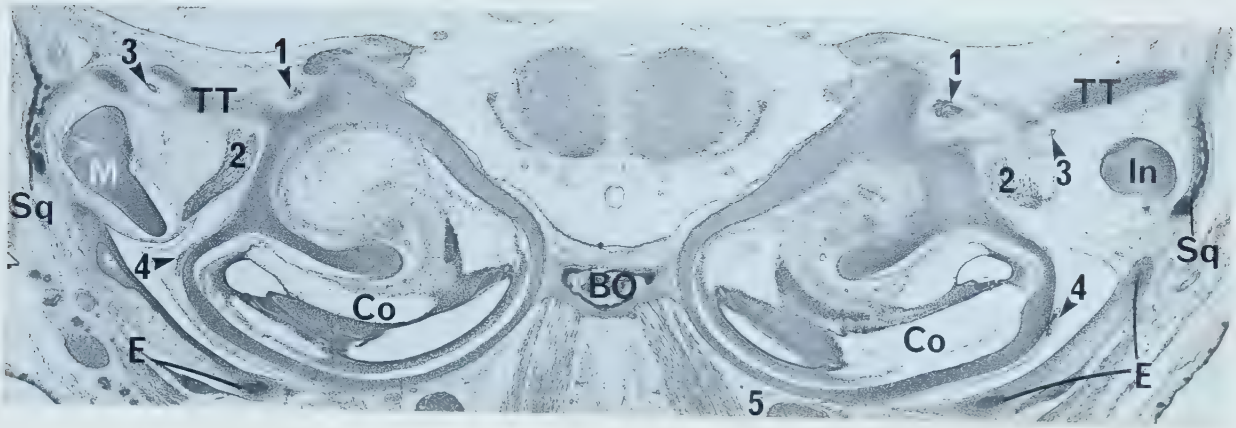
Growth of petrosal plate I. The auditory capsule is completely cartilaginous at this stage. The caudal tympanic process of the petrosal is present in cartilage (see fig. III-12), but the rostral process (which is solely a periosteal outgrowth) does not form until the ventral part of the promontory is ossified.

1, geniculate ganglion in cavum supracochleare; 2, tensor tympani m.; 3, stapedial a.; 4, promontorial a. and internal carotid n.; 5, FMTC.

FIG. III-4 G. demidovii MPIH 120 (fetus); s. 1072, cross-section, right side; Cresyl Violet; x 32.

Growth of the petrosal plate II. The pars cochlearis is substantially ossified by this stage and the rostral tympanic process of the petrosal is in the initial phase of its production. The short trabeculae composing the rostral process form a nearly-complete rampart of bone on the ventral surface of the promontory (see fig. III-1). Posteriorly, the rostral process adjoins the partly ossified caudal tympanic process of the petrosal (see figs. III-14, III-15).

1, anterior carotid a.; 2, chorda tympani; 3, lesser petrosal n.; 4, promontorial a.; 5, tensor tympani m.; 6, tympanic plexus in remnant of piriform fenestra; 7, auricular cartilage.


3
1
TT
2
M
Sq
4
BO
Co
E
5
1
TT
2
3
In
Sq
4
Co
E

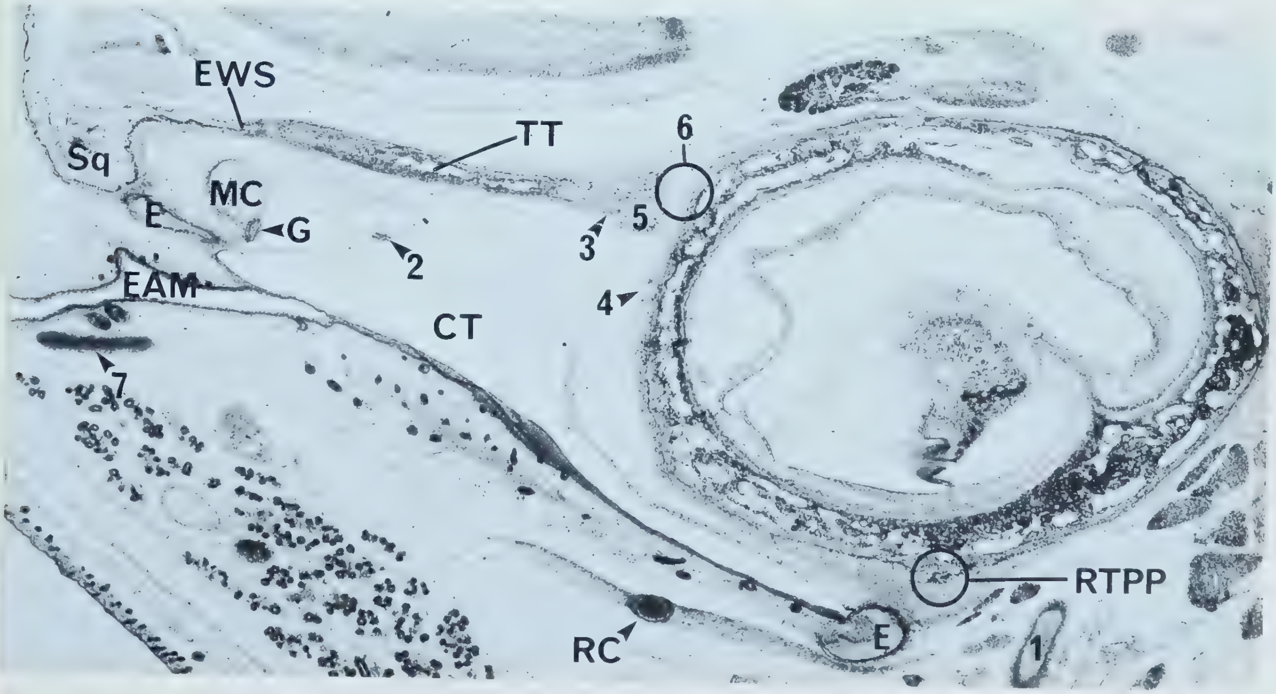

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FIG. III-5 G. senegalensis MPIH 1962/40 (newborn); s. 178/1, cross-section, left side; Azan; x 19.

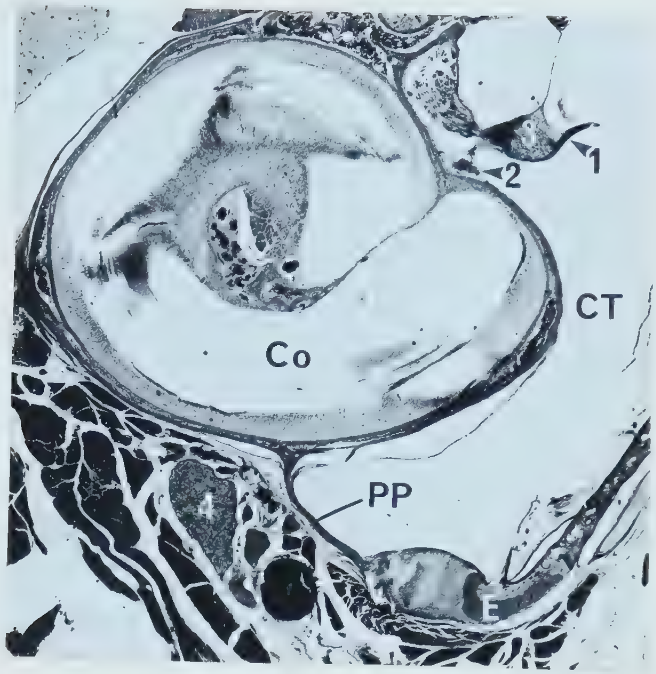
Growth of petrosal plate III. The petrosal plate is now quite large and bears a prominent ventral enlargement (as in young M. murinus; cf. figs. II-6, II-7).

1, chorda tympani travelling around tensor tympani m.; 2, internal carotid n.; 3, tensor tympani m.; 4, cranial cervical ganglion of autonomic nervous system.

FIG. III-6 G. senegalensis MPIH 1967/117 (10 days old); s. 530, sagittal, left side; Azan; x 15.

Growth of petrosal plate IV. The petrosal plate has begun to fuse with the ectotympanic (see also fig. III-9), thus producing the compound bulla characteristic of lorises. The final phase of bullar maturation involves the pneumatization of the entire petrosal plate and its division into medial and lateral lamellae (see figs. III-26, III-28). The mastoid cavity also extensively inflates the bone surrounding the parafloccular fossa.

1, chorda tympani; 2, stapedial a.; 3, tensor tympani m.; 4, auricular ramus of vagus; 5, internal carotid a. on tip of septum; 6, paraflocculus.



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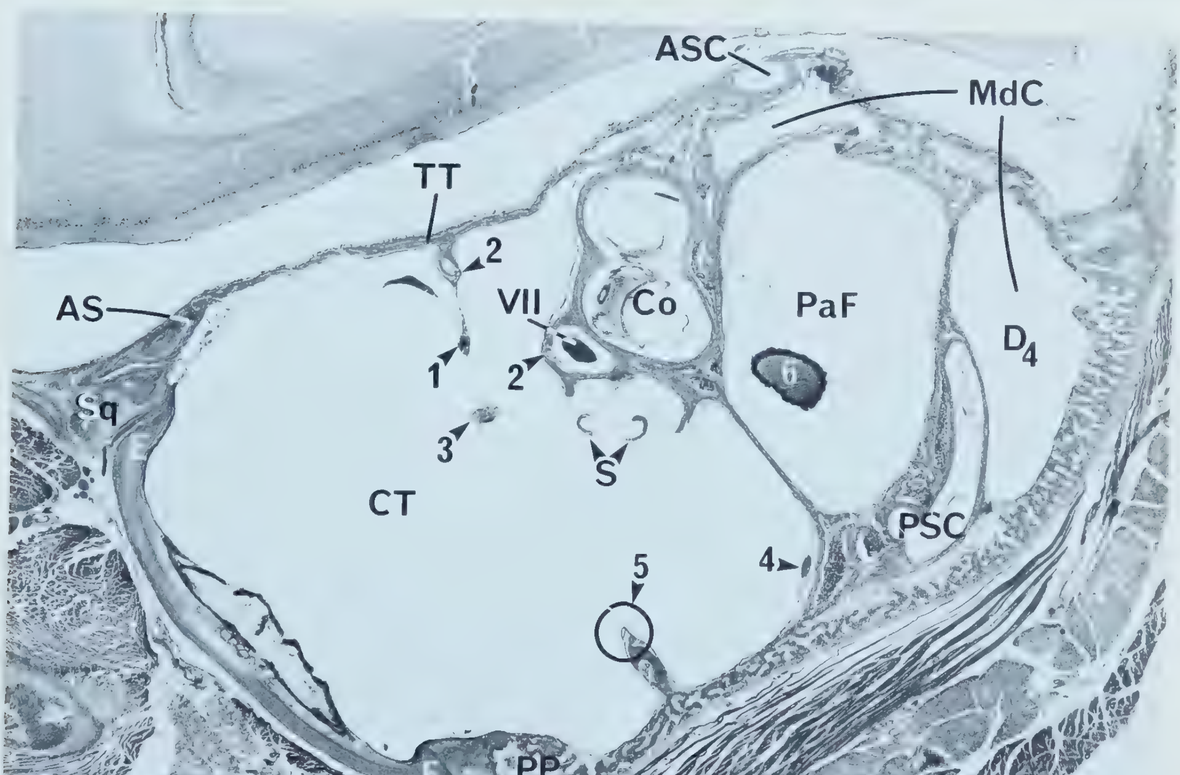

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FIG. III-7 _G. demidovii_ MPIH 120 (near-term fetus); s. 1198, cross-section, right side; Cresyl Violet; x 116.

Relationship of ectotympanic and petrosal plate I. Cresyl Violet does not adequately stain connective tissue fibres, and boundaries between sutural layers cannot be distinguished with certainty. The denser-staining area on the right is probably the fibrous membrane of the tympanic cavity.

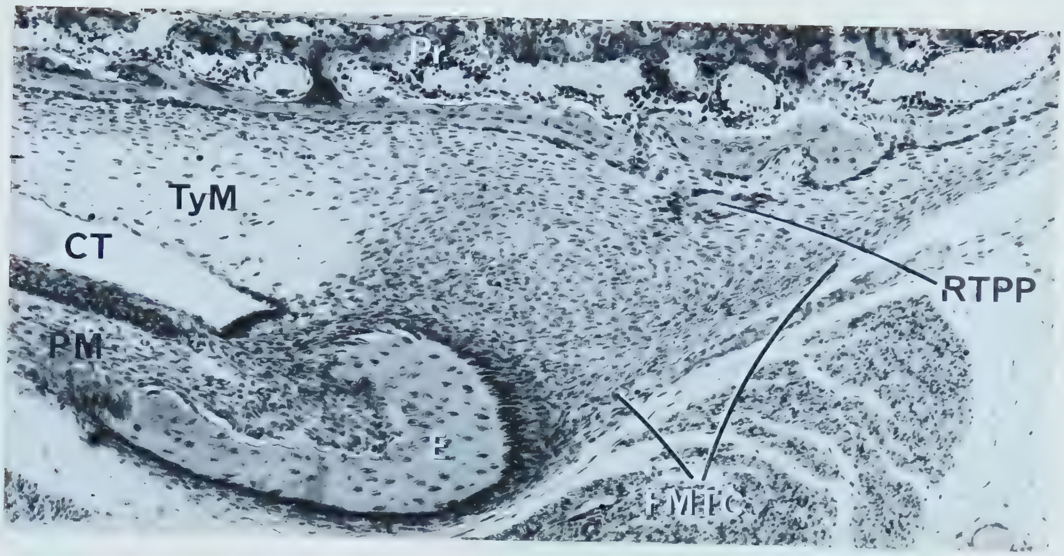
FIG. III-8

a. _G. demidovii_ MPIH 1962/40 (newborn); s. 145/3, cross-section, right side; Azan; x 119.

b. _L. tardigradus_ MPIH 1666 (near-term fetus); s. 617, cross-section, left side; Azan; x 34 and x 98.

Relationship of ectotympanic and petrosal plate II. Distinct, highly-fibrous uniting layers can be easily detected. They enclose, with the aid of the capsular layers of the ectotympanic and petrosal plate, a lighter-staining area which represents the middle layer. The definition and number of sutural tissues clearly contrasts with the state of sutural development seen in late fetal _Microcebus_.

1, capsular layer of petrosal plate; 2, capsular layer of ectotympanic; 3, middle layer; 4, uniting layer; 5, uniting layer (includes fibrous membrane of tympanic cavity).



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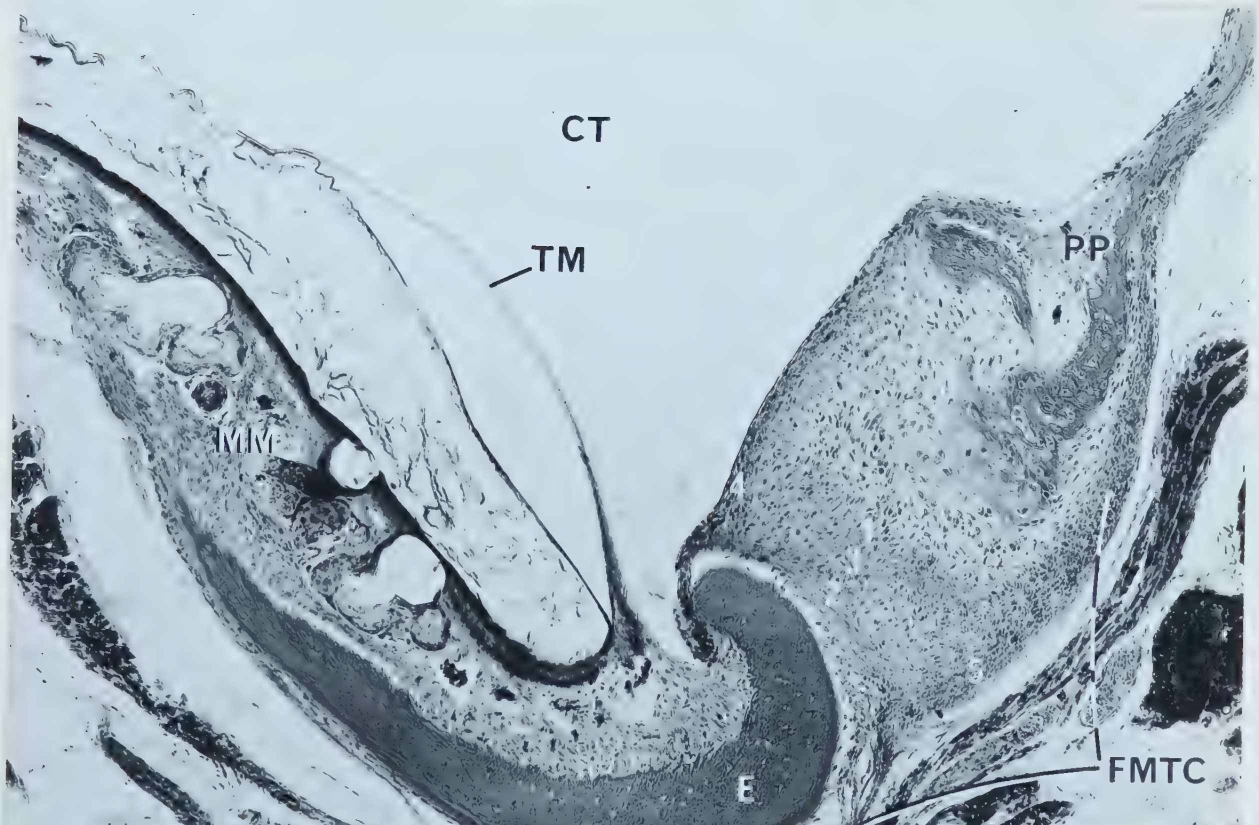

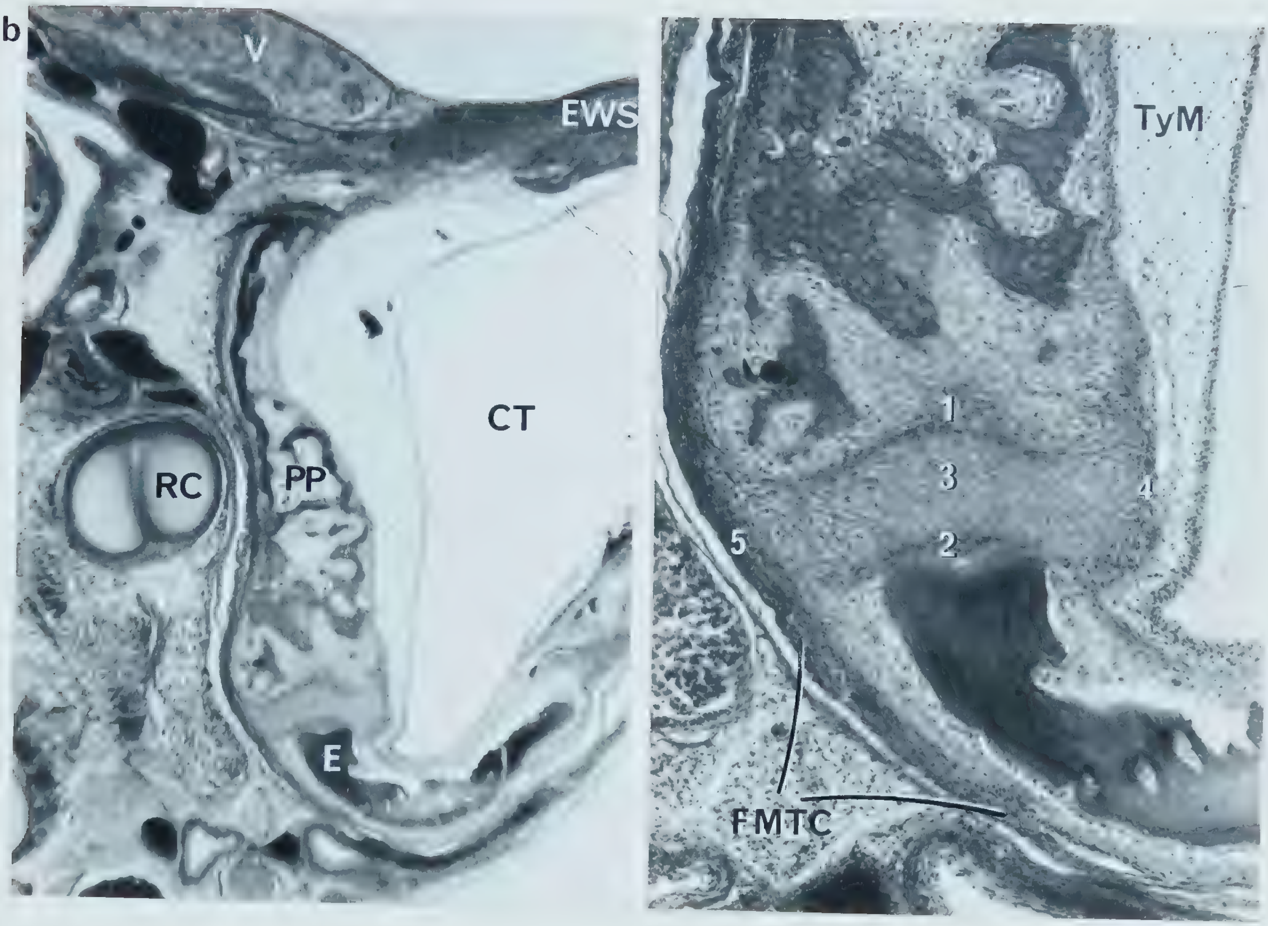

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FIG. III-9 G. senegalensis MPIH 1967/117 (10 days old); s. 530, sagittal, left side; Azan; x 89.

Relationship of ectotympanic and petrosal plate III. Spicules of bone can be identified within the ectotympanic-petrosal plate suture. In the superior part of the suture, there is a complete bridge of bone joining the petrosal plate and ectotympanic. In the ventral part, the bridge is still incomplete. Situated between the spicules and grading histologically into them is a poorly-organized tissue which resembles cartilage (cf. Reichert's cartilage, lower right). This material conforms to the transitory tissue described by MOSS (1958) for the metopic suture of the rat. With fusion of the two bone territories, the ectotympanic-petrosal plate relationship has reached its definitive form.

Asterisks indicate spicules of bone within ectotympanic-petrosal plate suture.


CT
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RC

561

FIG. III-10 G. demidovii MPIH 102 (fetus); s. 531, cross-section, right side (sides rev.); Cresyl Violet; x 41.

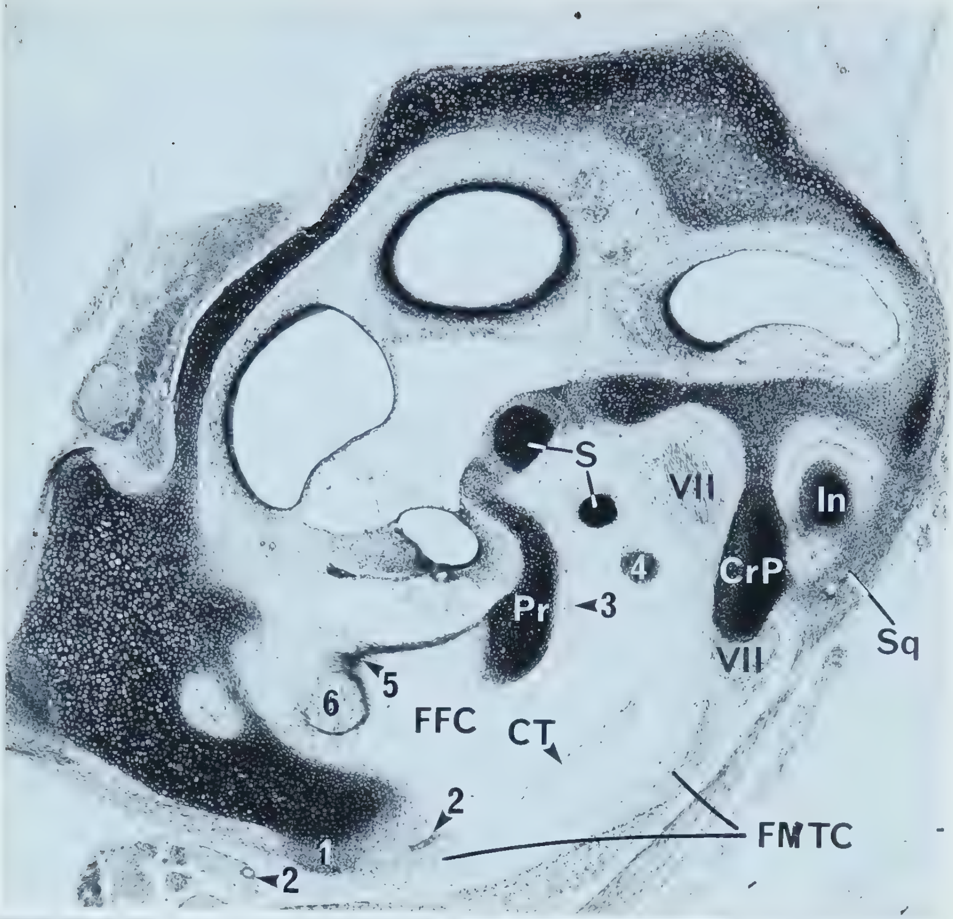
The end of the cochlear floor bears a small nodule of cartilage which represents the medial section of the caudal tympanic process of the petrosal. The cartilage composing this nodule is slightly younger than the rest of the cochlear floor.

1, medial section of the caudal tympanic process of the petrosal; 2, internal carotid a. and n.; 3, tympanic n.; 4, stapedius muscle; 5, secondary tympanic membrane; 6, perilymphatic duct; 7, internal jugular v.

FIG. III-11 G. demidovii MPIH 102 (fetus); s. 541, cross-section, right side (sides rev.); Cresyl Violet; x 45.

Directly behind the medial section of the caudal tympanic process of the petrosal, and joining the posterior end of the floor of the pars cochlearis to the anteroventral part of the pars canalicularis, is the processus recessus (future medial wall of the fossula fenestrae cochleae). The internal carotid a. enters the presumptive tympanic cavity beneath the processus recessus.

For key to numbered structures, see fig. III-10.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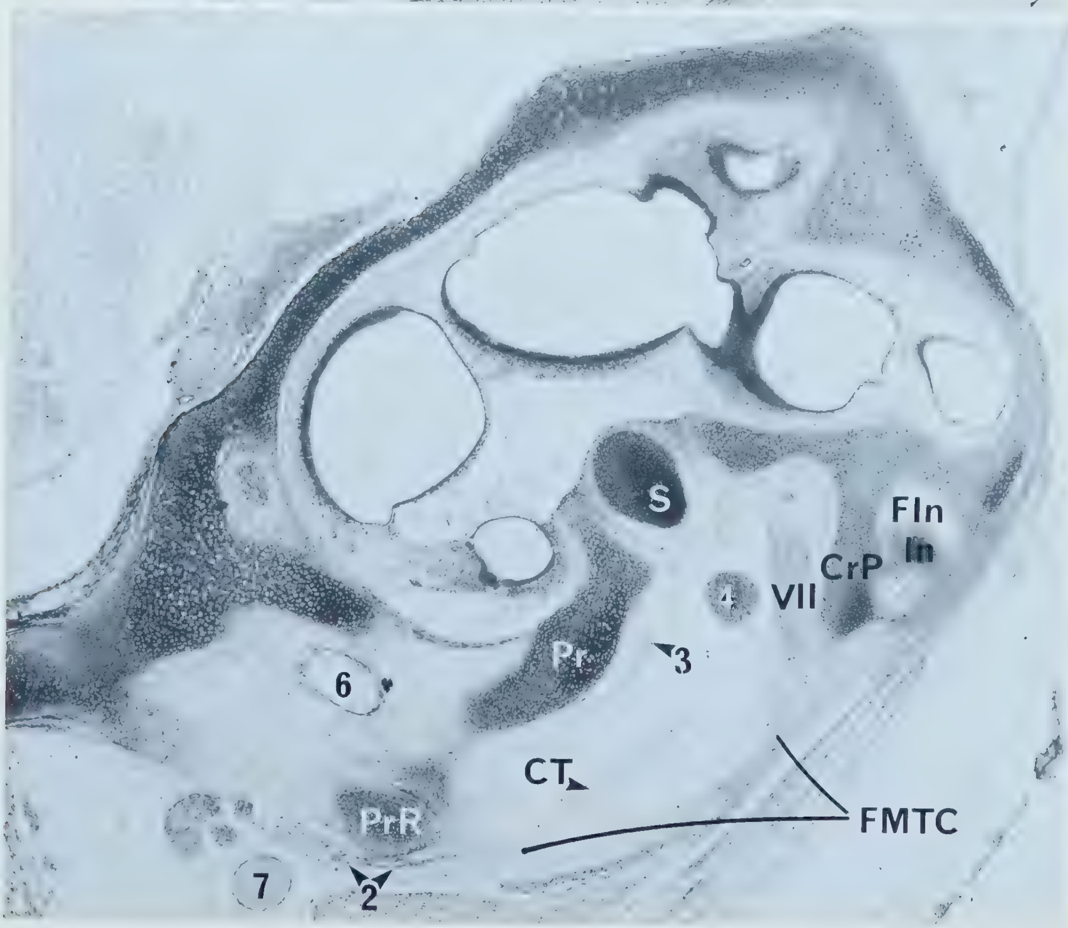
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563

FIG. III-12 *G. demidovii* MPIH 102 (fetus); s. 549, cross-section, left side; Cresyl Violet; x 45.

The crista parotica is continued posteriorly by the massive posterolateral section of the caudal tympanic process of the petrosal.

1, perilymphatic duct; 2, auricular ramus of the vagus entering rear of tympanic cavity; 3, stapedius m.; 4, fissura metotica; 5, IX and X nerves; 6, internal jugular v.

FIG. III-13 *G. demidovii* MPIH 120 (near-term fetus); s. 961, cross-section, left side; Cresyl Violet; x 33.

The anterior carotid enters a simple rete before passing into the cranial cavity. The branches of the rete rejoin, and the reconstituted anterior carotid (now as the cerebral carotid) receives the promontorial a. before reaching the circulus arteriosus.

1, rete of anterior carotid a.; 2, petro-occipital sinus; 3, cavernous sinus; 4, secondary cartilage in postglenoid process; 5, anterior carotid-promontorial a. anastomosis entering foramen caroticum primitivum; 6, promontorial a. joining anterior carotid a.; 7, nerves of pterygoid canal; 8, external jugular v.


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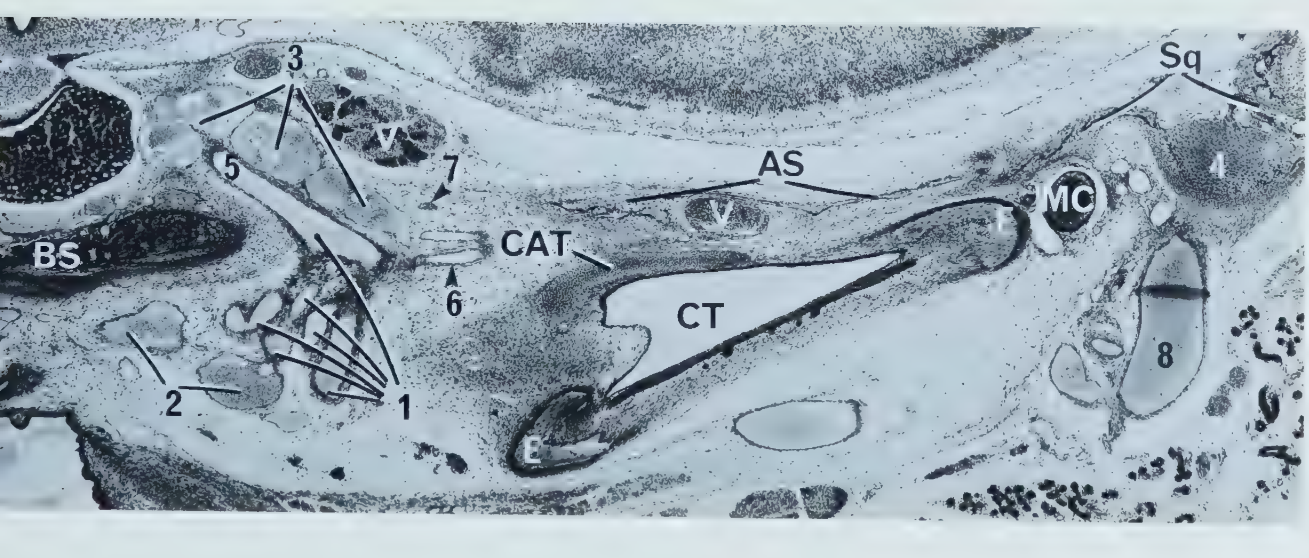
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FIG. III-14 G. demidovii MPIH 120 (near-term fetus); s. 1210, cross-section, left side; Cresyl Violet; x 28.

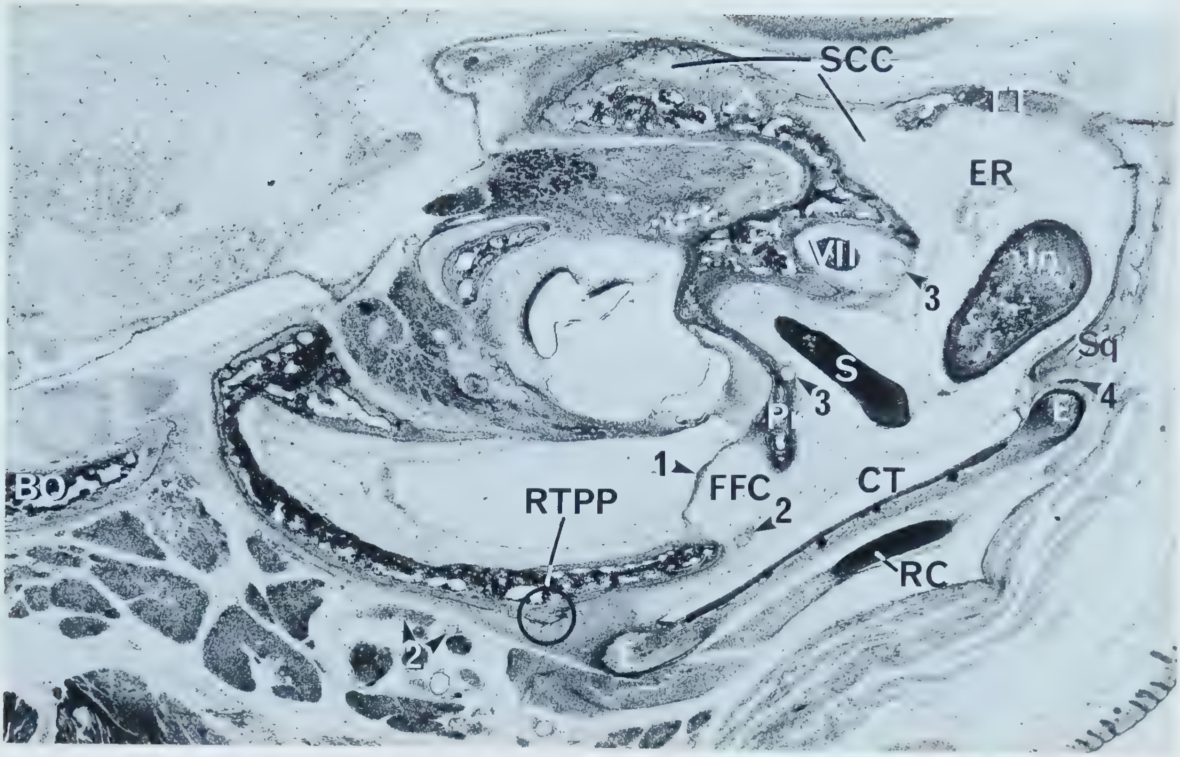
The supracochlear cavity originates as a dorsomedial diverticulum of the epitympanic recess which gradually inflates into the dorsal (cerebral) surface of pars cochlearis and, eventually, the anterior part of the petrosal plate.

1, secondary tympanic membrane; 2, internal carotid a. and n.; 3, stapedial a.; 4, chorda tympani; 5, tendon of stapedius m.

FIG. III-15 G. demidovii MPIH 120 (near-term fetus); s. 1237; cross-section, left side; Cresyl Violet; x 32.

The cartilaginous medial section of the caudal tympanic process of the petrosal is now partly surrounded by periosteal splints. These splints are in turn continuous with the trabeculae of the rostral tympanic process of the petrosal (see fig. III-1).

For key to numbered structures, see fig. III-14.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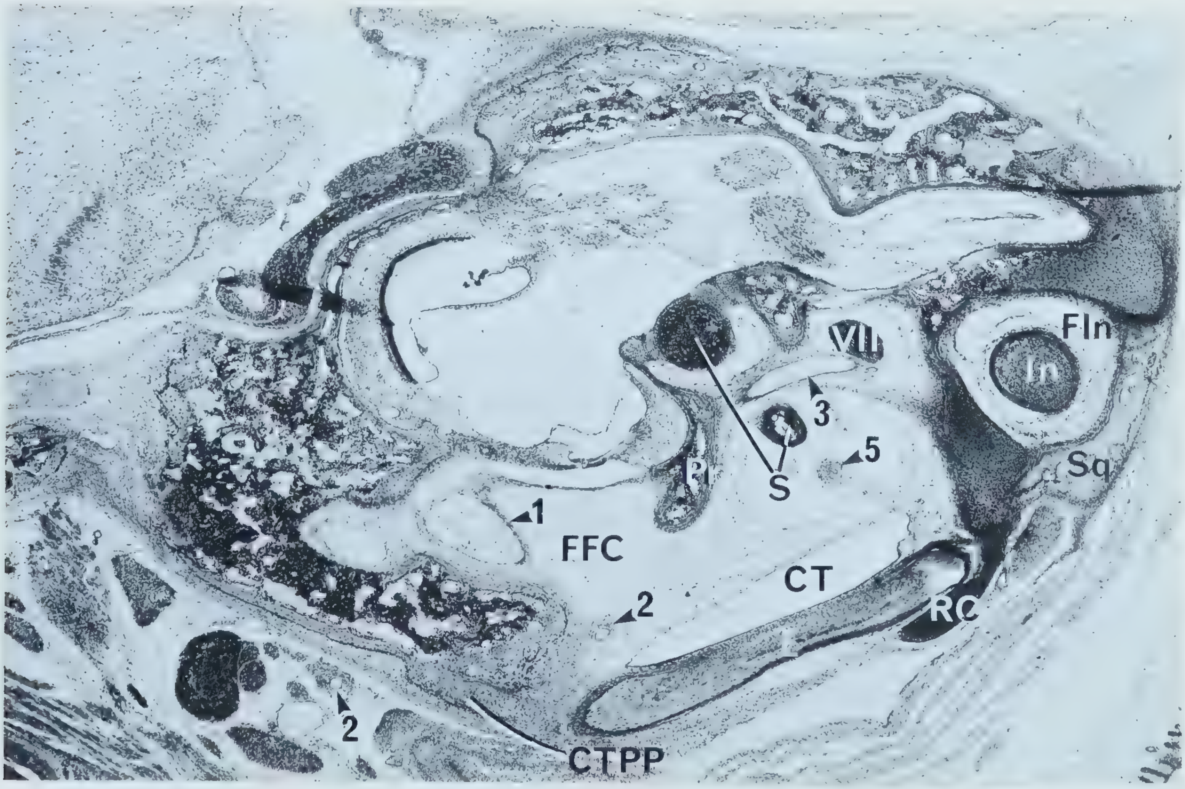
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FIG. III-16 G. demidovii MPIH 120 (near-term fetus); s. 1201, cross-section, right side; Cresyl Violet; x 32.

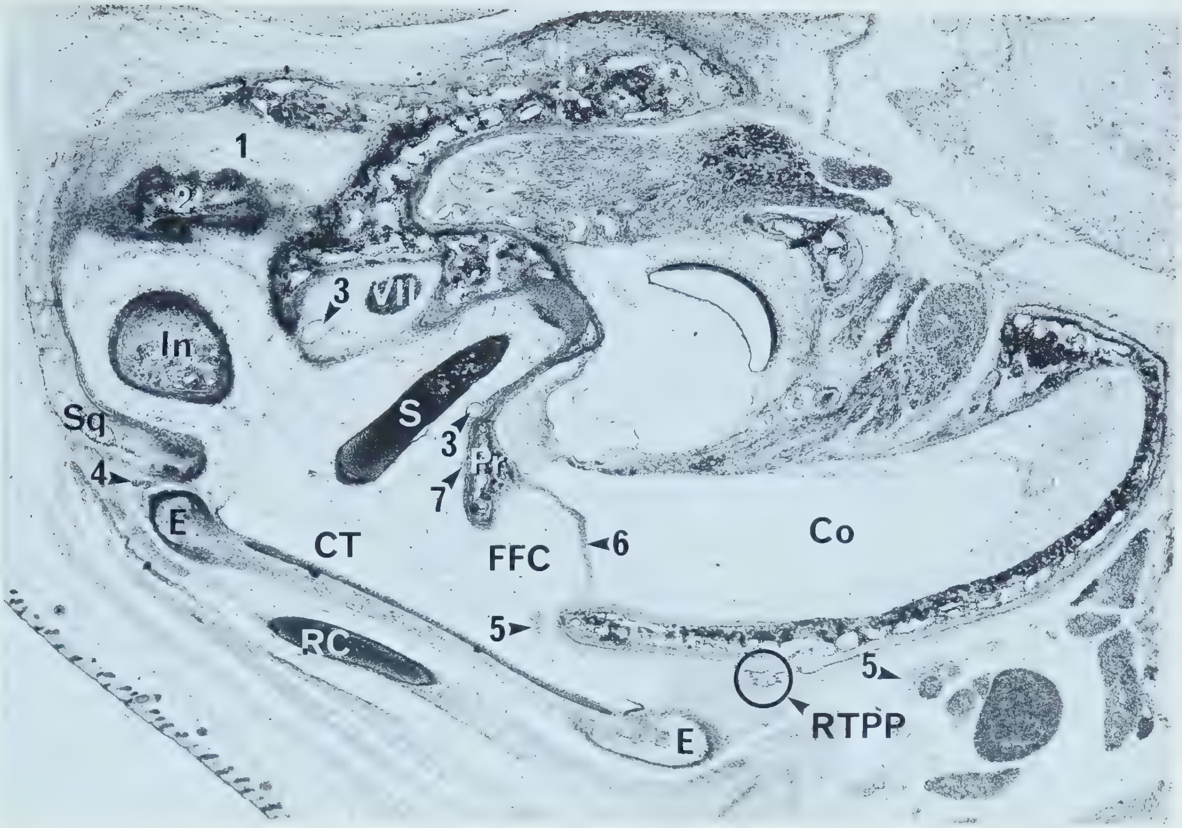
The root of the tegmen tympani and the adjacent part of the pars canaliculus have been excavated by pneumatic activity, partially exposing the wall of the lateral semicircular canal. Further pneumatization in this region produces the definitive aditus ad antrum and, later, the mastoid cavity (antrum and D_4).

1, area of excavation above lateral semicircular canal (future aditus); 2, wall of lateral semicircular canal; 3, stapedial a.; 4, chorda tympani; 5, internal carotid a. and n.; 6, secondary tympanic membrane; 7, tympanic n.

FIG. III-17 G. demidovii MPIH 120 (near-term fetus); s. 1243, cross-section, right side; Cresyl Violet; x 32.

The cartilaginous medial section of the caudal tympanic process of the petrosal is enclosed by periosteal splints (asterisks). Conditions in older specimens suggests that these splints do not continue to lay down bone in the cavity formed by the degeneration of the cartilage of the original medial section of the process. Instead, the splints become the side walls of a small diverticulum which opens into the tympanic cavity beneath the fossula fenestrae cochleae (see figs. III-22, III-23).

1, tympanic n.; 2, internal carotid a. and n.; 3, stapedius m.; 4, perilymphatic duct.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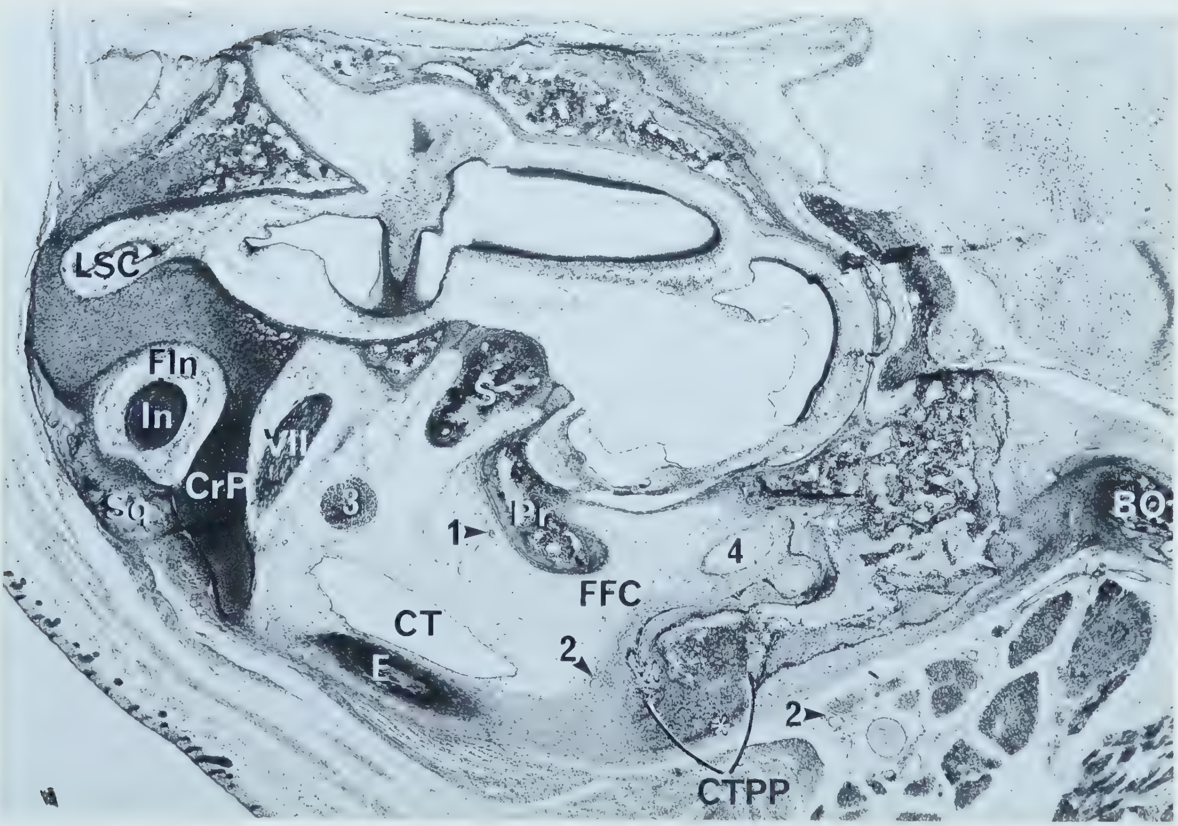
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FIG. III-18 G. demidovii MPIH 120 (near-term fetus); s. 1258, cross-section, right side (sides rev.); Cresyl Violet; x 28.

A narrow cartilaginous bridge joins together the medial and posterolateral sections of the caudal tympanic process of the petrosal. This bridge helps define a long, slit-like foramen through which the internal carotid a. and the internal carotid, tympanic, and auricular ramus of the vagus nn. enter the presumptive tympanic cavity (see fig. III-1).

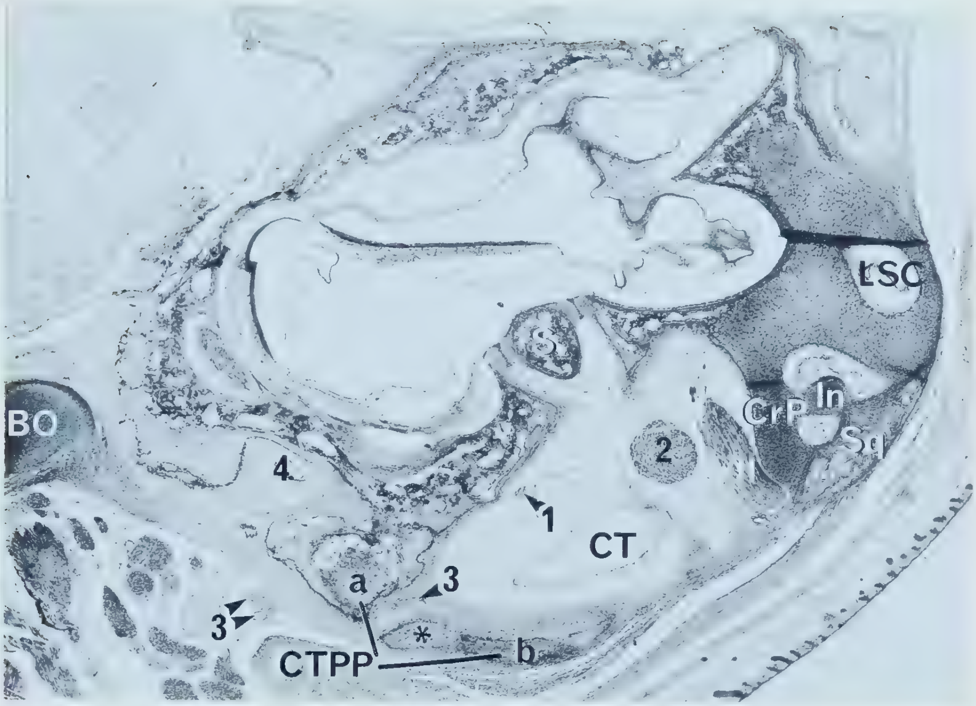
The letter 'a' indicates the medial, and the letter 'b' the posterolateral, sections of the CTPP. The cartilaginous bridge is identified by the asterisk.

1, tympanic n.; 2, stapedius m.; 3, internal carotid a. and n.; 4, perilymphatic duct; 5, auricular ramus of the vagus; 6, fissura metotica.

FIG. III-19 G. demidovii MPIH 120 (near-term fetus); s. 1285, cross-section, right side (sides rev.); Cresyl Violet; x 28.

The posterolateral section of the caudal tympanic process of the petrosal is mostly cartilaginous at this stage. It ossifies from a center in the anteroventral part of pars canalicularis.

For key to numbered structures, see fig. III-18.



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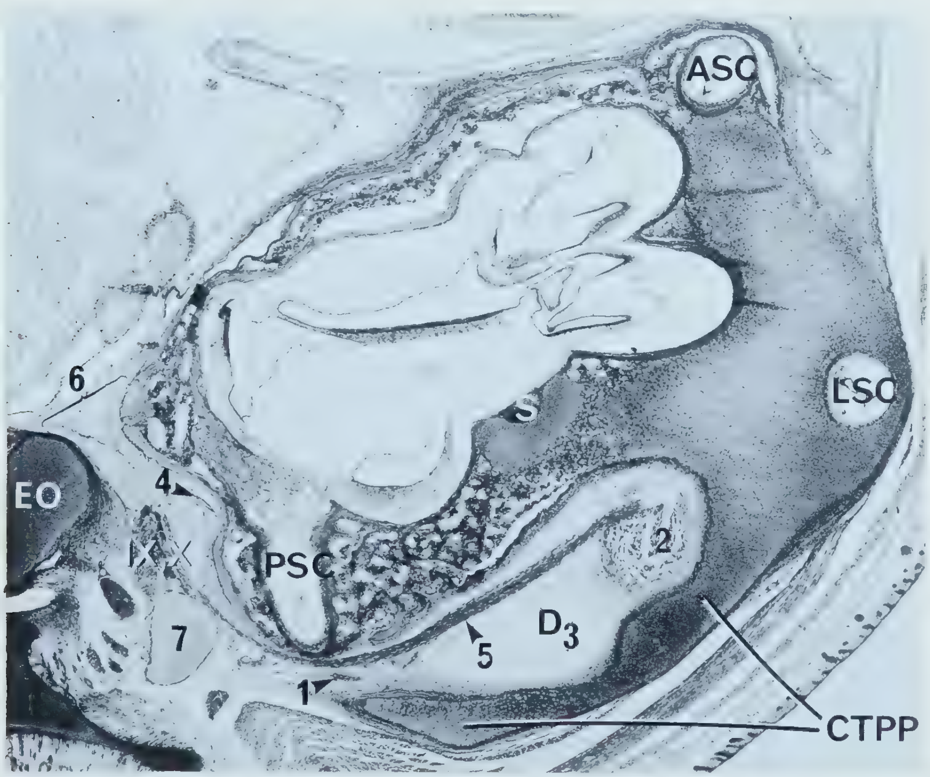

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FIG. III-20 G. senegalensis MPIH 1962/40 (newborn); s. 133/1/1; cross-section, right side; Azan; x 28.

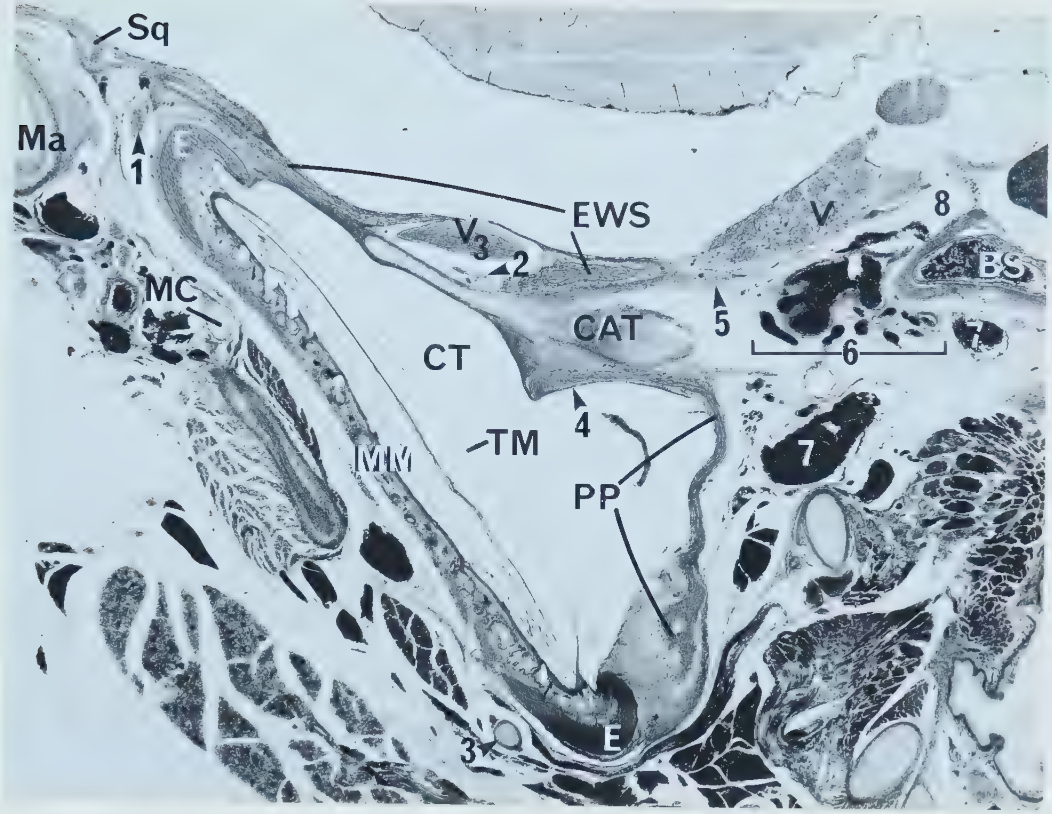
Anterior end of the tympanic cavity. The petrosal plate sends out a large lamina which forms the ventral part of the tubal canal. Note the participation of the alisphenoid (as the epitympanic wing of the sphenoid) in the roof of the tympanic cavity.

1, chorda tympani; 2, lesser petrosal n.; 3, Reichert's cartilage; 4, floor of tubal canal (formed by petrosal plate); 5, nerves of the pterygoid canal; 6, rete of the anterior carotid a.; 7, petro-occipital sinus; 8, cavernous sinus; 9, promontorial a. joining anterior carotid a.

FIG. III-21 G. senegalensis MPIH 1962/40 (newborn); s. 135/3, cross-section, right side; Azan; x 31.

The promontorial a. passes between the alisphenoid and the petrosal part of tubal canal in order to reach the anterior carotid beneath the anterior carotid foramen.

For key to numbered structures, see fig. III-20.



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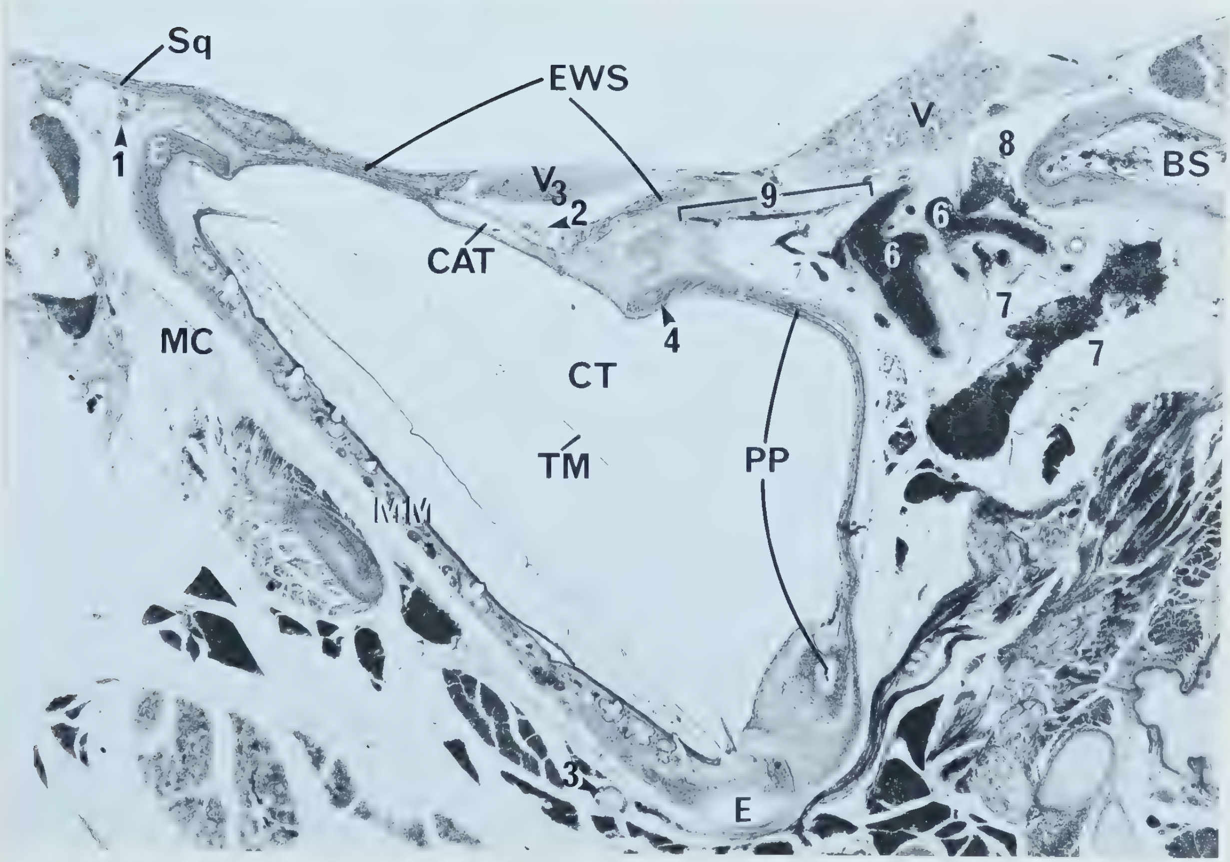

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FIG. III-22 G. senegalensis MPIH 1962/40 (newborn); s. 193/2/1, cross-section, right side; Azan; x 28.

The small diverticulum (5) beneath the fossula fenestra cochleae is not part of the developing medial accessory cavity, despite the appearance of this section. The diverticulum is continuous with the tympanic cavity and derived from the medial section of the original CTPP (see fig. III-17). It is wide but very short; it terminates only a few micra posterior to this section (see fig. III-23). In the adult (fig. III-2) this diverticulum is visible as a small indentation of the lateral lamella of the petrosal plate ('longitudinal septum'). The true medial accessory cavity will later expand into the medial sidewall of the diverticulum.

1, tendon of stapedius m.; 2, tympanic n.; 3, internal carotid a. entering tympanic cavity through posterior carotid foramen; 4, secondary tympanic membrane; 5, diverticulum; 6, sidewall of lateral semicircular canal; 7, posterior end of supracochlear cavity.

FIG. III-23 G. senegalensis MPIH 1962/40 (newborn); s. 196/2/3, cross-section, right side; Azan; x 28.

The mastoid cavity is undergoing rapid development in this specimen (see also figs. III-24, III-25).

For key to numbered structures, see fig. III-22.

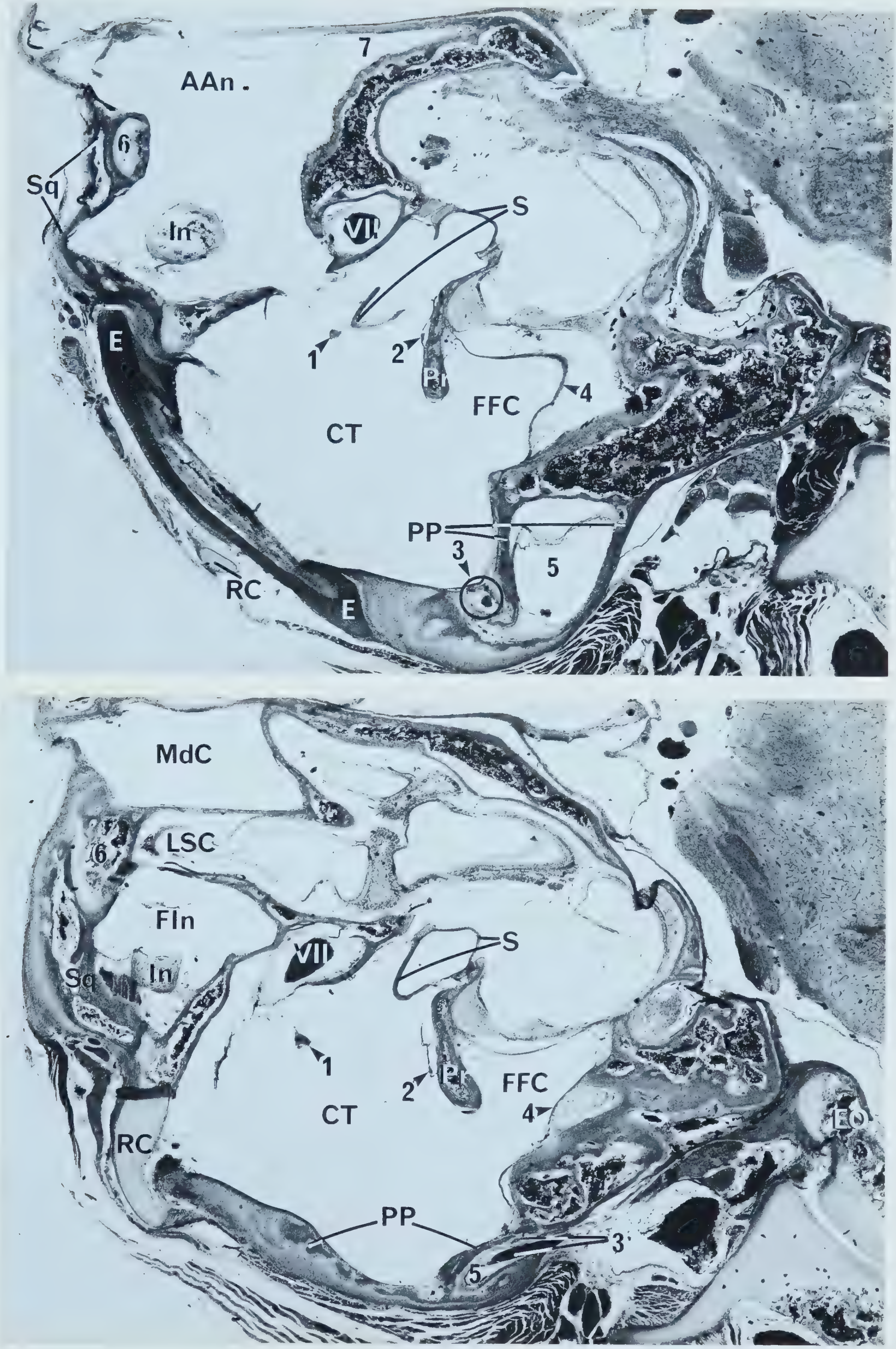

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FIG. III-24 G. senegalensis MPIH 1962/40 (newborn); s. 198/1/2, cross-section, left side; Azan; x 28.

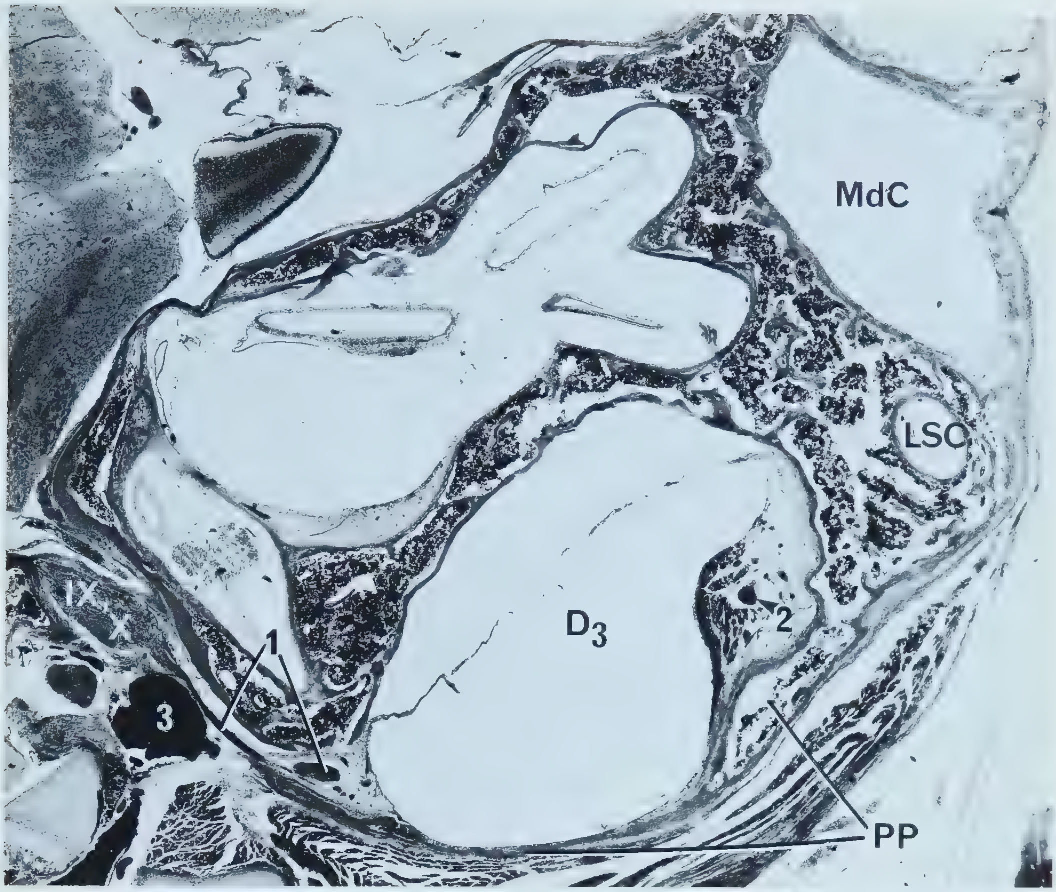
Mastoid cavity and posterior end of the tympanic cavity (D_3). The mastoid cavity is still expanding rapidly, unlike the ventral wall of D_3. The auricular ramus of the vagus appears twice in this section (see also fig. III-25) because it travels around the posterior wall of D_3 before proceeding anteriorly.

1, auricular ramus of vagus and tympanic nn. entering posterior end of tympanic cavity; 2, auricular ramus of vagus n. passing through fossa for stapedius m.; 3, internal jugular v.

FIG. III-25 G. senegalensis MPIH 1962/40 (newborn); s. 204/2/1, cross-section, left side; Azan; x 28.

Mastoid cavity and posterior end of tympanic cavity (D_3).

For key to numbered structures, see fig. III-24.



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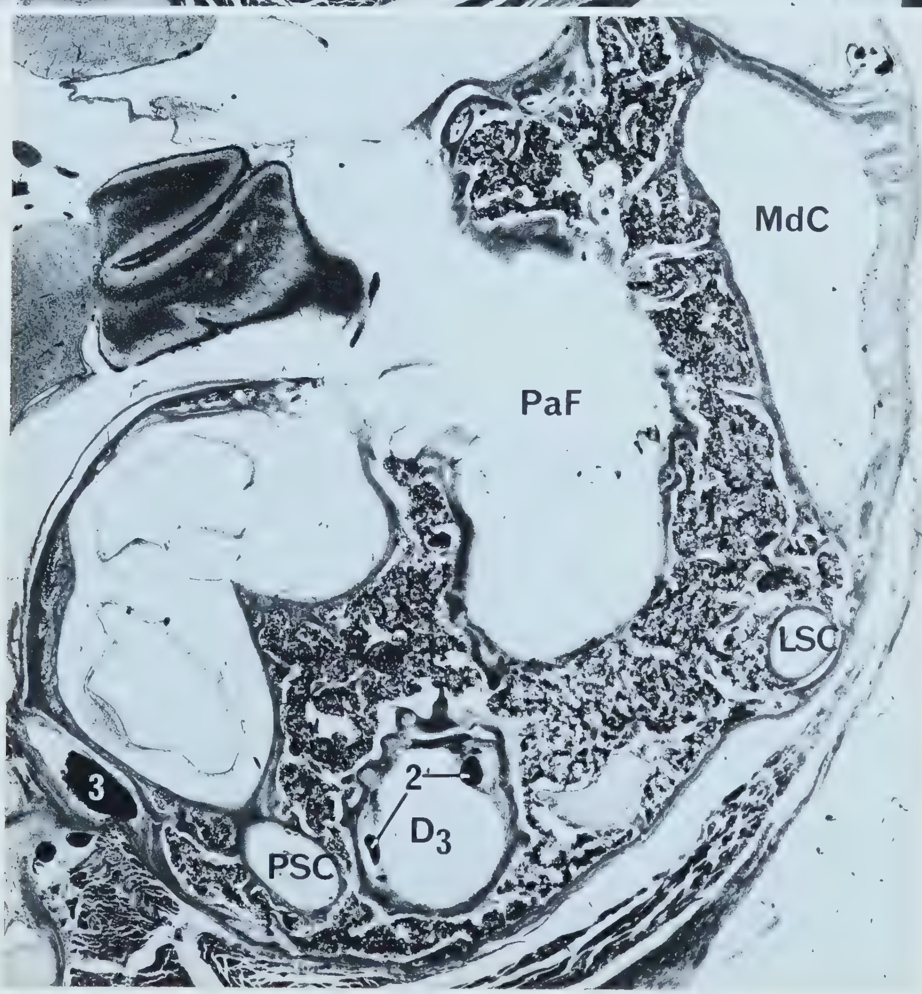

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D_3
PSC

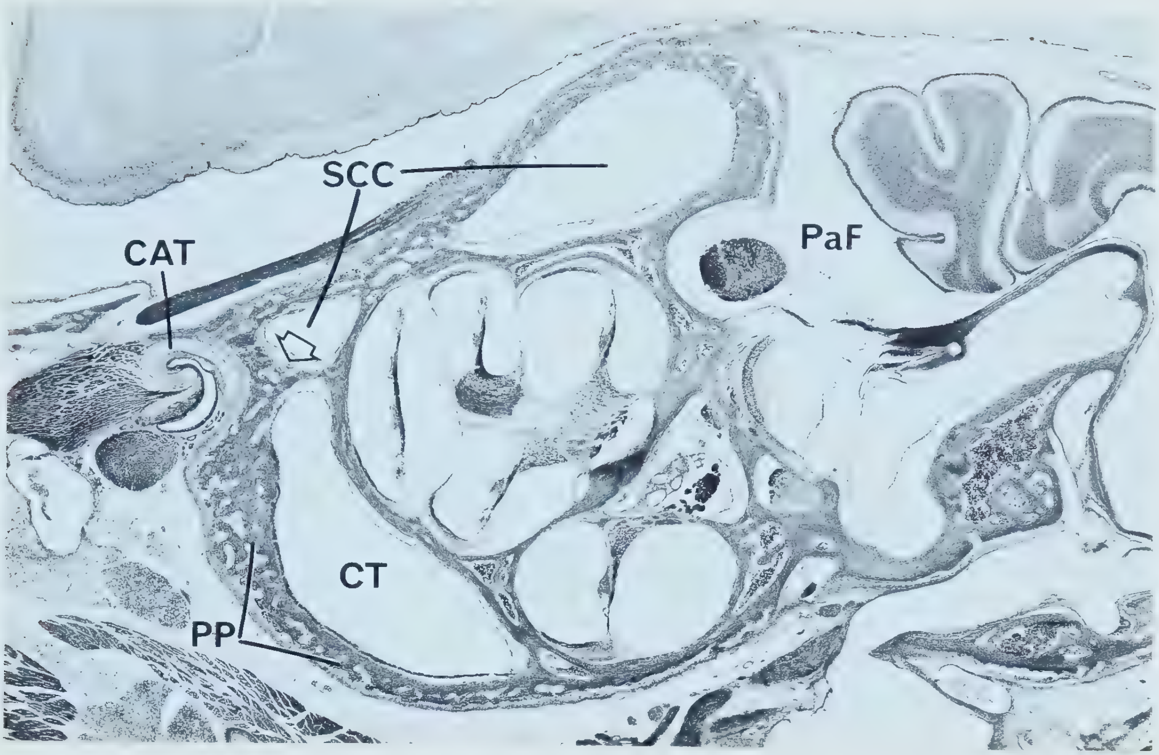
FIG. III-26 *G. senegalensis* MPIH 1967/117 (10 days old); s. 670, sagittal section, left side; Azan; x 18.

Section through medial part of auditory capsule. The supracochlear cavity reaches the anterior end of pars cochlearis and then penetrates the petrosal plate. Inflation of the petrosal plate has just begun in this specimen (direction indicated by outline arrow).

FIG. III-27 *G. senegalensis* MPIH 1967/117 (10 days old); s. 570, sagittal section, left side; Azan; x 16.

Section through central part of auditory capsule. The supracochlear cavity inflates the whole dorsal (cerebral) surface of the pars cochlearis. The mastoid cavity eventually isolates the parafloccular fossa from the sidewall of the skull.

1, anterior semicircular canal; 2, posterior semicircular canal; 3, ampullar end of posterior semicircular canal; 4, tensor tympani m.; 5, facial n.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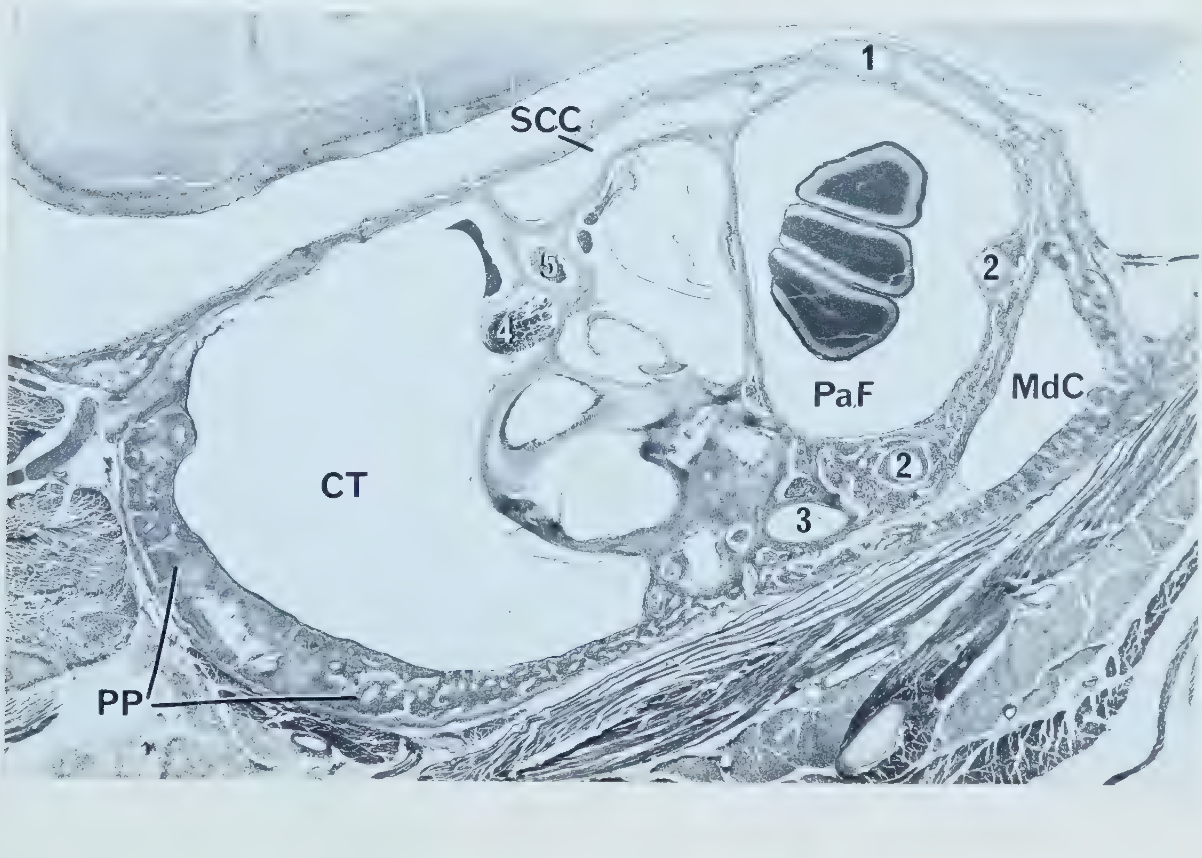
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FIG. III-28 *G. senegalensis* MPIH 1967/117 (10 days old); s. 440, sagittal section, left side; Azan; x 18.

Section through lateral part of auditory capsule. This section illustrates the relationship of the true tympanic cavity, epitympanic recess, and mastoid cavity to each other and to other parts of the middle ear. Diverticulum D_4 is the ventromedial extension of the mastoid cavity which extends into the posterior part of the petrosal plate in postnatal life. Pneumatic effects are already visible, for only a thin plate of bone (3) lies between the tympanic cavity and D_4.

1, septum within mastoid cavity; 2, lateral semicircular canal; 3, posterior wall of tympanic cavity; 4, facial n.; 5, stapedius m.


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FIG. III-29 *Tarsius bancanus* MPIH 1963/13 (adult); s. 1825, cross-section, left side; Azan; x 172.

In *Tarsius*, as in *Galago,* the bone of the ectotympanic remains intermediate in architecture after fusion with the petrosal plate. Despite the appearance of this section, the petrosal plate does not actually overgrow the ectotympanic. New bone of the mature, lamellated type is laid down laterally over the original ectotympanic, this obscures the position of the ectotympanic-petrosal plate suture in the adult.

The white outline arrows indicate the border between intermediate and lamellated bone in this section.


E
PP

583

FIG. III-30 Auditory region of a 27 mm HL _Loris tardigradus_, alizarin preparation; after RAMASWAMI (1957). Only bony areas are stained.

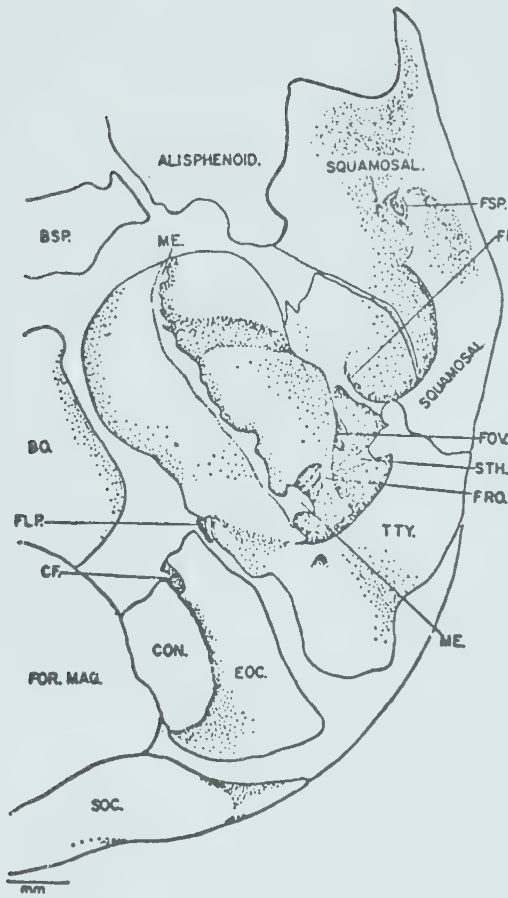
The 'mastoid extension' is equivalent to the rostral tympanic process of the petrosal and the medial section of the caudal tympanic process of the petrosal. The posterolateral section of the caudal tympanic process is identified by the asterisk (*).

BO., basioccipital; BSP., basisphenoid; CF., hypoglossal foramen; CON., occipital condyle; EOC., exoccipital; FBV., stapedial foramen; FLP., posterior lacerate foramen; FOR. MAG., foramen magnum; FOV., apertura fenestrae vestibuli; FRO., apertura fossulae fenestrae cochleae; FSP., postglenoid foramen; ME., 'mastoid extension'; SOC., supraoccipital; STH., stylohyal.

FIG. III-31 Auditory regions of 'juvenile' specimens of _Perodicticus potto_ and _Loris tardigradus_; after VAN KAMPEN (1905); x 3.5.

The medial half of the promontory is still exposed ventrally in these specimens, no doubt due to the small size of the medial accessory cavity in young lorises.

a.s., alisphenoid; a.t., ectotympanic; b., petrosal bulla (petrosal plate); b.o., basioccipital; e.o., exoccipital; f.c., anterior carotid foramen; f.c.e., posterior carotid foramen; f. md., mandibular fossa; f.g., postglenoid foramen; f.o., foramen ovale; f.s., stylomastoid foramen; m., mastoid region; m.t., tympanic membrane; p.p., promontory or pars cochlearis; t., ectotympanic.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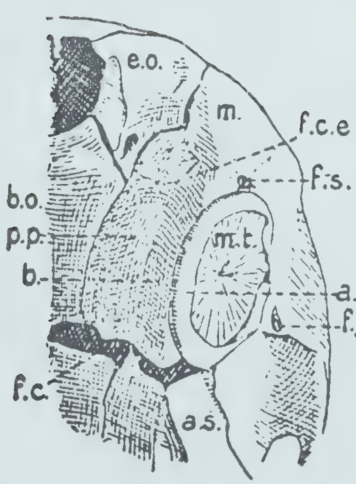
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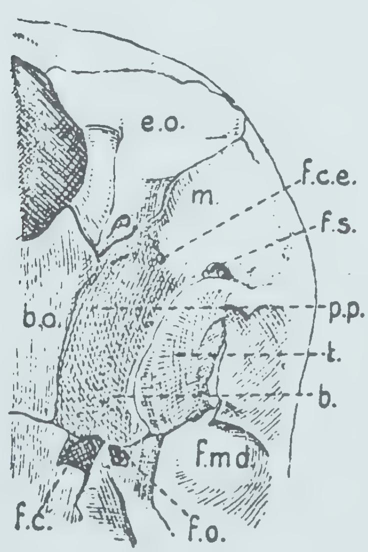
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FIG. III-32 L. tardigradus MPIH 1666 (near-term fetus); s. 719, cross-section, right side; Azan; x 25.

Developing supracochlear cavity.

1, stapedial a.; 2, developing supracochlear cavity; 3, internal carotid a. and n.

FIG. III-33 L. tardigradus MPIH 1666 (near-term fetus); s. 737, cross-section, right side; Azan; x 25.

Loris lacks the small diverticulum beneath the fossula fenestrae cochleae which is found in Galago (cf. fig. III-22). The developing antrum has already attained large size.

1, stapedial a.; 2, supracochlear cavity; 3, internal carotid n. and tympanic n.; 4, internal carotid a.; 5, sidewall of lateral semicircular canal; 6, secondary tympanic membrane.


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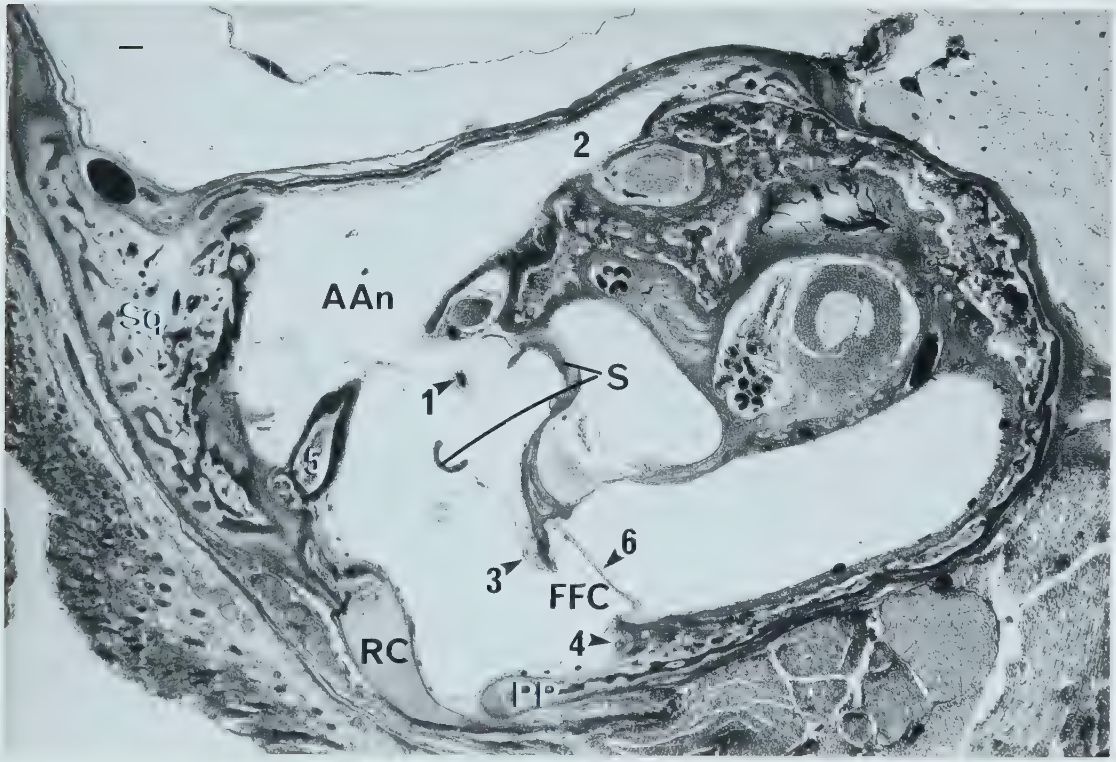
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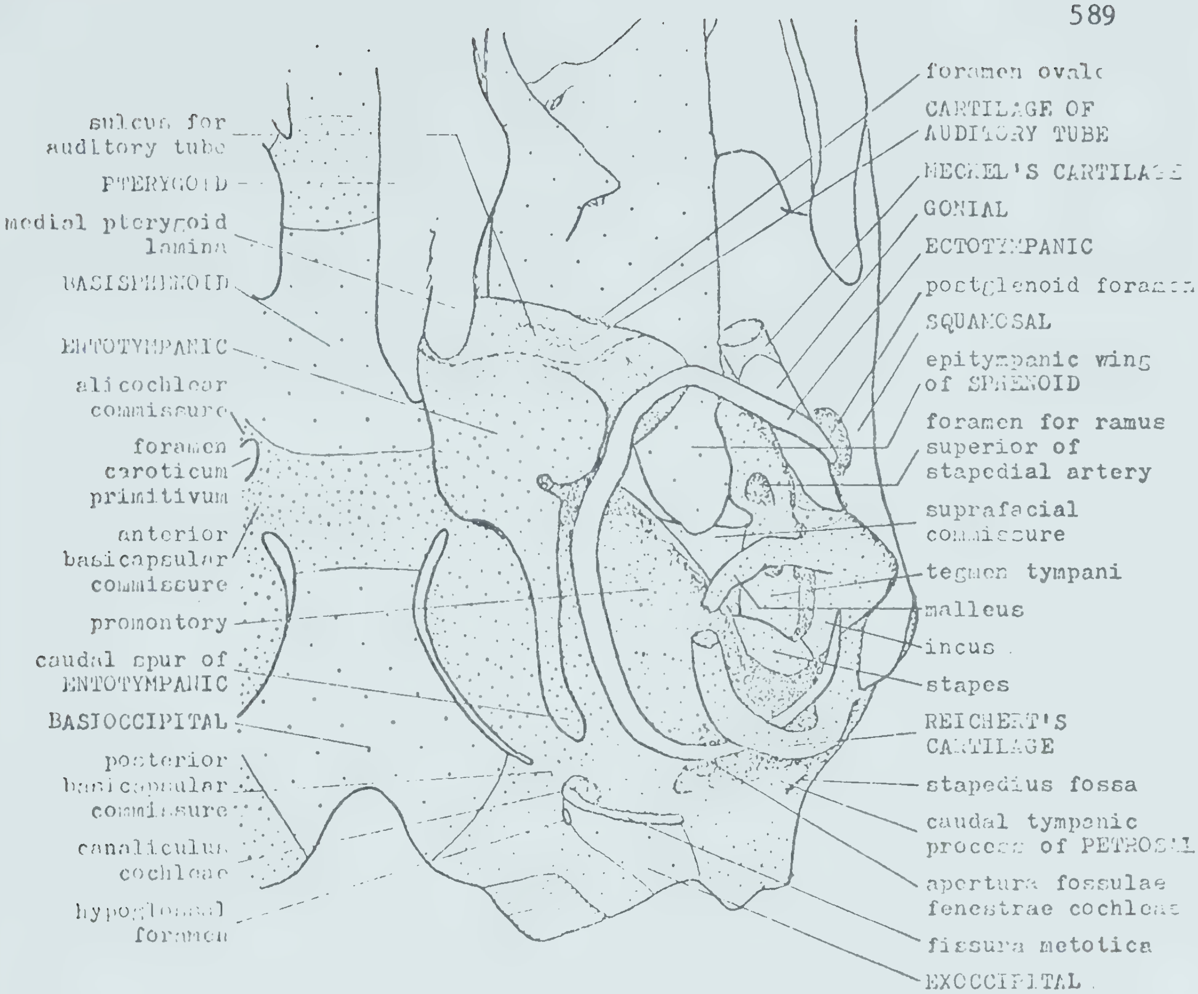
FIG. IV-1 *T. glis* MPIH 1959/4 (near-term fetus). Reconstruction of left auditory region and associated structures, ca. x 12 (after SPATZ 1966).

It is not possible to subdivide precisely the anterior mass of cartilage into separate tubal and entotympanic components. The dashed line, however, roughly indicates where the boundary between the two probably lies. The chief feature of this stage is the long caudal spur of the entotympanic which grows within the fibrous membrane of the tympanic cavity.

FIG. IV-2 *T. glis* MPIH 1960/77 (newborn). Reconstruction of left auditory region and associated structures, ca. x 12 (after SPATZ 1966).

The entotympanic has fused with the auditory capsule in two places: anteriorly with the tegmen tympani (*) and posteriorly with the tympanic process of the petrosal (**). Additionally, the caudal spur has broadened considerably and now covers a large portion of the ecto-tympanic--rendering it partially aphaneric.


sulcus for auditory tube
PTERYGOID
medial pterygoid lamina
BASISPHENOID
ENTOTYMPANIC
alicochlear commissure
foramen caroticum primitivum
anterior basicapsular commissure
promontory
caudal spur of ENTOTYMPANIC
BASIOCCIPITAL
posterior basicapsular commissure
canaliculus cochleae
hypoglossal foramen
foramen ovale
CARTILAGE OF AUDITORY TUBE
MECKEL'S CARTILAGE
GONIAL
ECTOTYMPANIC
postglenoid foramen
SQUAMOSAL
epitympanic wing of SPHENOID
foramen for ramus superior of stapedial artery
suprafacial commissure
tegmen tympani
malleus
incus
stapes
REICHERT'S CARTILAGE
stapedius fossa
caudal tympanic process of PETROSAL
apertura fossulae fenestrae cochleae
fissura metotica
EXOCCIPITAL

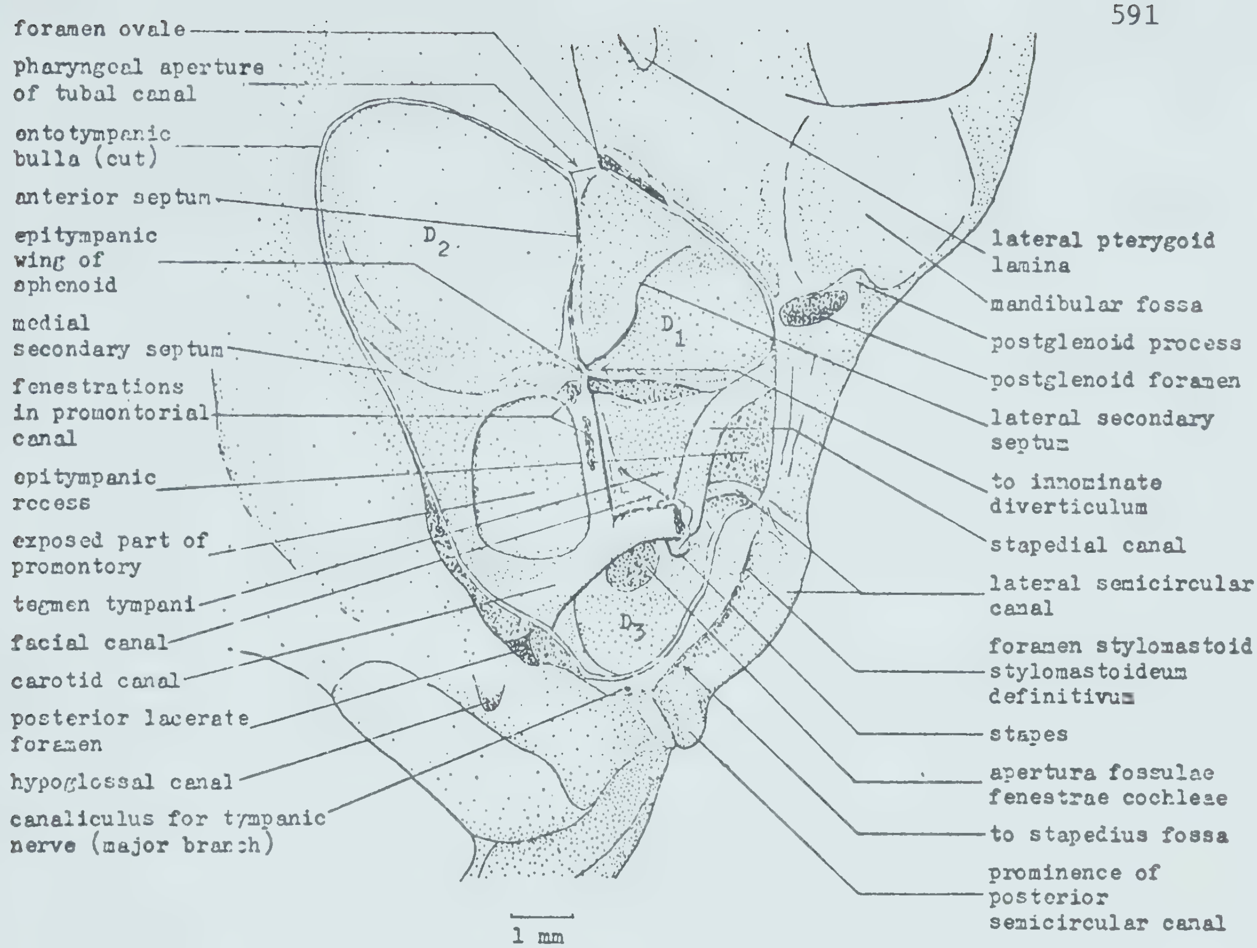

*
**

FIG. IV-3 *T. glis* adult. General view of left auditory region, ventral aspect.

The ectotympanic and most of the ventral part of the entotympanic (which forms the bulla proper) has been removed. This figure should be compared to fig. IV-4.

FIG. IV-4 *T. glis* adult. Further dissection of the left auditory region of the same specimen illustrated in fig. IV-3.

The entire entotympanic has been removed except for the part covering the internal carotid artery and the medial section of diverticulum D_3. The true extent of the epitympanic wing of the persphenoid, the small epitympanic wing of the petrosal, and the persistent piriform fenestra are now revealed. Removal of the dorsal parts of the entotympanic also clearly exposes the almost-complete ring of small cristae which externally buttress the bulla.


foramen ovale
pharyngeal aperture of tubal canal
entotympanic bulla (cut)
anterior septum
epitympanic wing of sphenoid
medial secondary septum
fenestrations in promontorial canal
epitympanic recess
exposed part of promontory
tegmen tympani
facial canal
carotid canal
posterior lacerate foramen
hypoglossal canal
canaliculus for tympanic nerve (major branch)
D_2
D_1
D_3
lateral pterygoid lamina
mandibular fossa
postglenoid process
postglenoid foramen
lateral secondary septum
to innominate diverticulum
stapedial canal
lateral semicircular canal
foramen stylomastoid stylomastoideum definitivum
stapes
apertura fossulae fenestrae cochleae
to stapedius fossa
prominence of posterior semicircular canal
1 mm

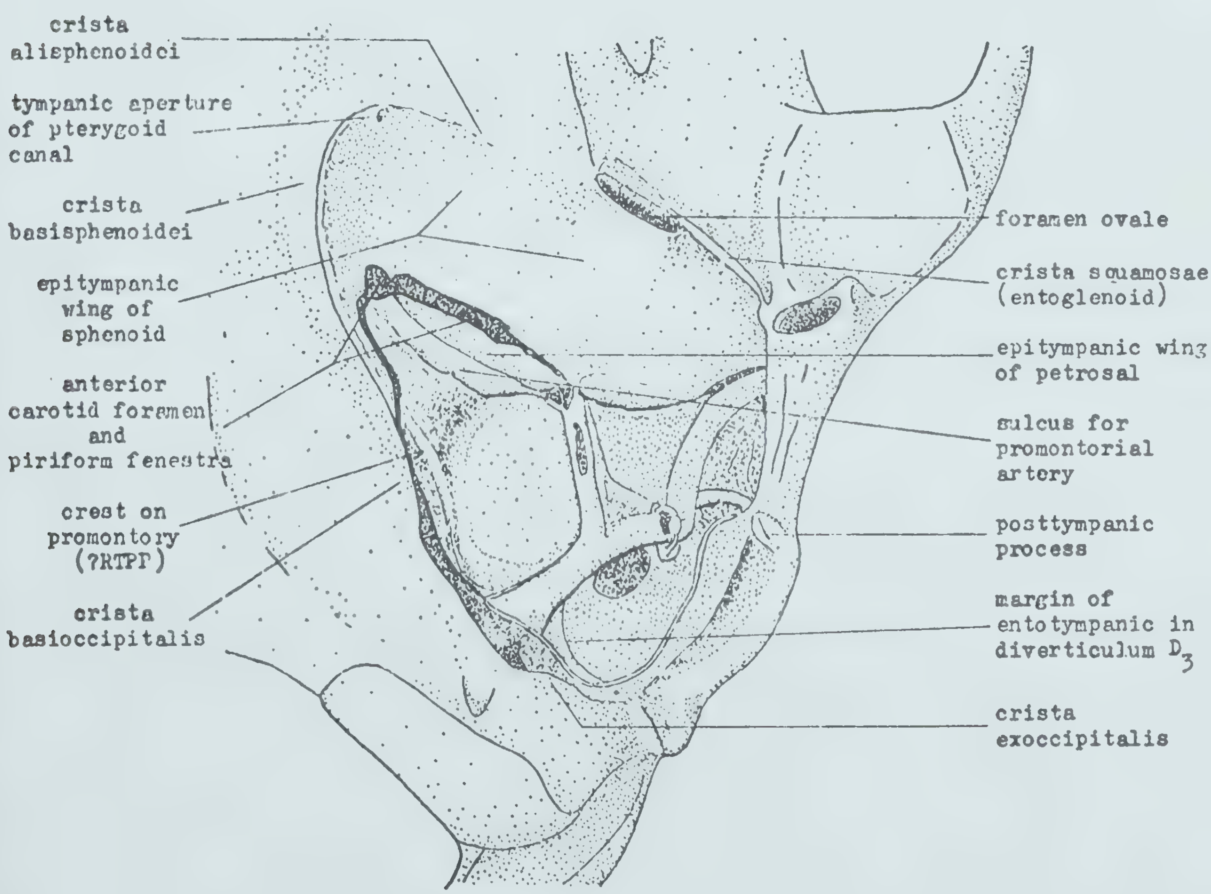
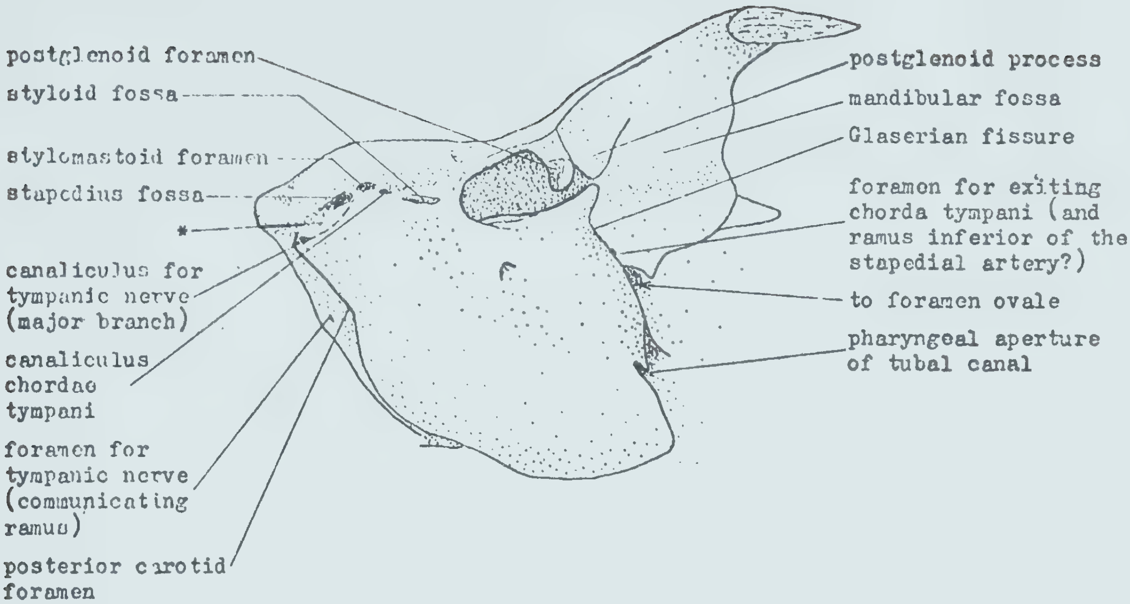

crista alisphenoidei
tympanic aperture of pterygoid canal
crista basisphenoidei
epitympanic wing of sphenoid
anterior carotid foramen and piriform fenestra
crest on promontory (?RTPF)
crista basioccipitalis
foramen ovale
crista squamosae (entoglenoid)
epitympanic wing of petrosal
sulcus for promontorial artery
posttympanic process
margin of entotympanic in diverticulum D_3
crista exoccipitalis

FIG. IV-5 *T. glis* adult. Right auditory region, ventrolateral aspect (after SABAN 1963).

The area bordered by the dashed line (*) represents the probable maximum extent of the caudal tympanic process of the petrosal in the adult.

FIG. IV-6 Major arteries and nerves of the middle ear in *T. glis* (semidiagrammatic).

1, promontorial artery (to circulus arteriosus); 2, nerves of the pterygoid canal (deep petrosal and greater petrosal); 3, greater petrosal nerve (to pterygopalatine ganglion); 4, lesser petrosal nerve (to otic ganglion); 5, ramus inferior of the stapedial artery (to 'internal' maxillary artery); 6, tympanic plexus; 7, canal for proximal part of stapedial artery; 8, ramus superior of stapedial artery (middle meningeal); 9, medial branch of internal carotid nerve; 10, lateral branch of internal carotid nerve; 11, tympanic nerve (major branch); 12, inferior tympanic artery; 13, stapes; 14, apertura fossulae fenestrae cochleae; 15, chorda tympani (to lingual nerve); 16, facial (VII) nerve; 17, internal carotid artery; 18, stem of internal carotid nerve; 19, tympanic nerve (communicating ramus); 20, auricular ramus of vagus nerve.


postglenoid foramen
styloid fossa
stylomastoid foramen
stapedius fossa
*
canaliculus for tympanic nerve (major branch)
canaliculus chordae tympani
foramen for tympanic nerve (communicating ramus)
posterior carotid foramen
postglenoid process
mandibular fossa
Glaserian fissure
foramen for exiting chorda tympani (and ramus inferior of the stapedial artery?)
to foramen ovale
pharyngeal aperture of tubal canal

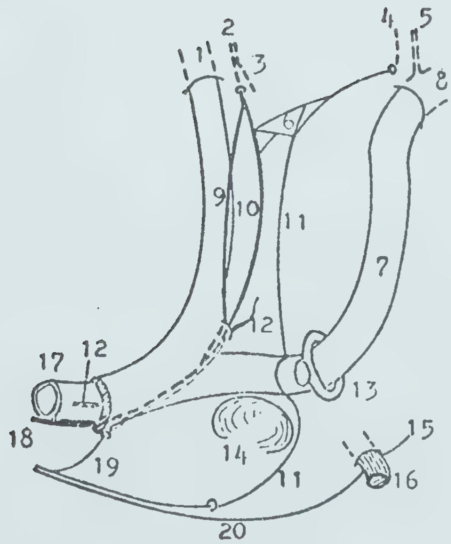

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FIG. IV-7 *T. glis* MPIH 1960/82a (near-term fetus); s. 1050, cross-section, right side (sides rev.); Azan; x 31.

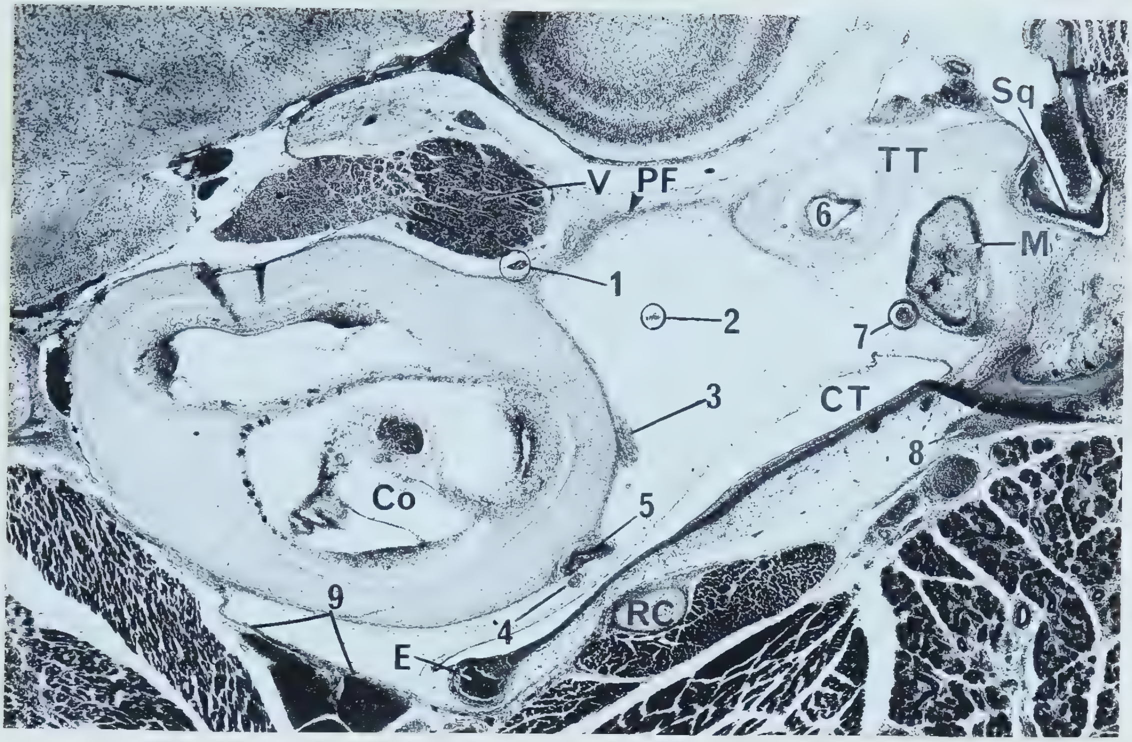
Growth of the entotympanic I. At this stage the ventral wall is almost entirely membranous. The anterior mass of cartilage (presumably consisting of both tubal and entotympanic material) is present, but it is limited to the anterior part of the presumptive tympanic cavity and does not appear in this section.

1, greater petrosal n.; 2, tympanic n. (major branch); 3, internal carotid n. (lateral branch); 4, internal carotid n. (medial branch); 5, promontorial a.; 6, (proximal) stapedial a.; 7, chorda tympani; 8, auricular cartilage; 9, FMTC.

FIG. IV-8 *T. glis* MPIH 1959/4; s. 336/2, cross-section, left side; Azan; x 27.

Growth of the entotympanic II. A lengthy caudal spur, presumably consisting only of entotympanic material, has grown out from the anterior mass of cartilage within the fibrous membrane of the tympanic cavity (cf. figs. IV-1, IV-12).

1, greater petrosal n.; 2, tympanic n. (major branch); 3, promontorial a.; 4, internal carotid n. (lateral branch); 5, internal carotid n. (medial branch); 6, (proximal) stapedial a.; 7, chorda tympani; 8, auricular cartilage; 9, FMTC.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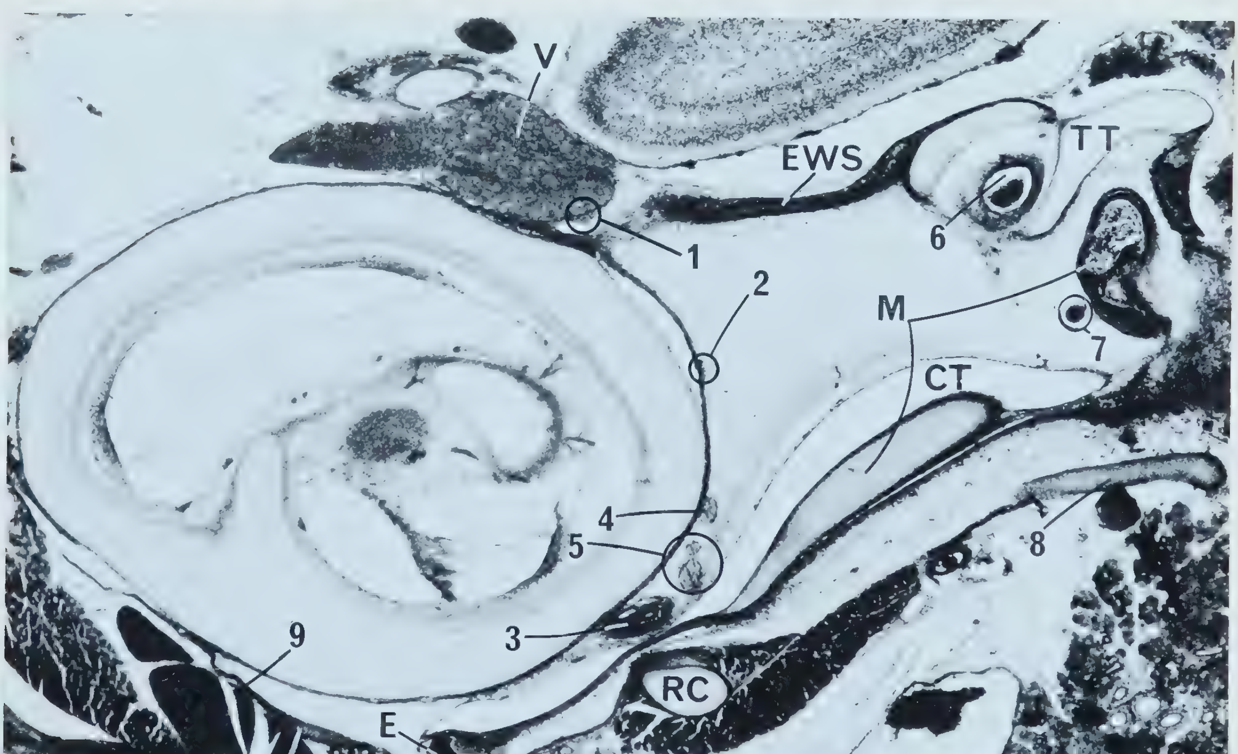
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FIG. IV-9 _T. glis_ MPIH 1960/77 (8 days old); s. 1330, cross-section, left side; Azan; x 26.

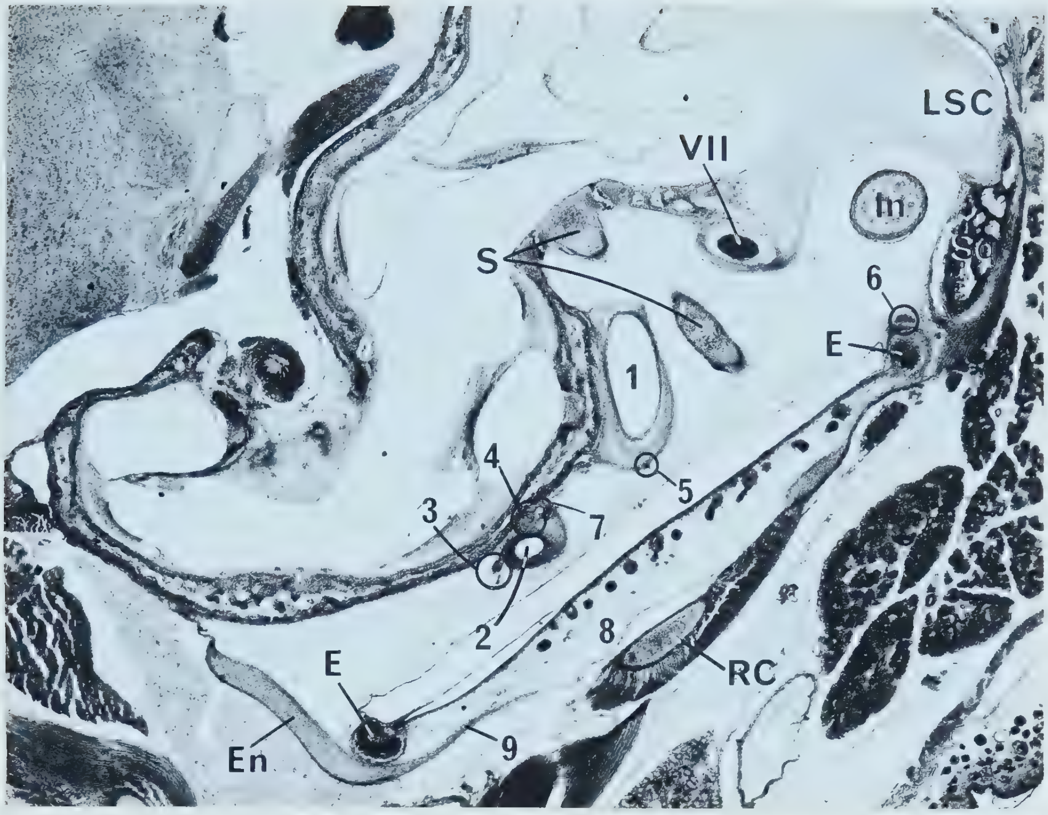
Growth of the entotympanic III. The entotympanic now covers a portion of the ectotympanic, rendering it partially aphaneric (cf. figs. IV-2, IV-13). The cavum tympani is still small; the rest of the presumptive tympanic cavity is filled with mucoid tissue.

1, (proximal), stapedial a.; 2, promontorial a.; 3, internal carotid n. (medial branch); 4, internal carotid n. (lateral branch); 5, tympanic n. (major branch); 6, chorda tympani; 7, inferior tympanic a.; 8, presumptive tissue of membranous meatus; 9, FMTC.

FIG. IV-10 _T. glis_ MPIH 1964/10 (19 days old); s. 1435, cross-section, left side; Azan; x 27.

Growth of the entotympanic IV. The entotympanic forms a complete, cartilaginous ventral wall for the tympanic cavity.

1, (proximal), stapedial a.; 2, promontorial a.; 3, chorda tympani; 4, auricular cartilage; 5, external acoustic meatus.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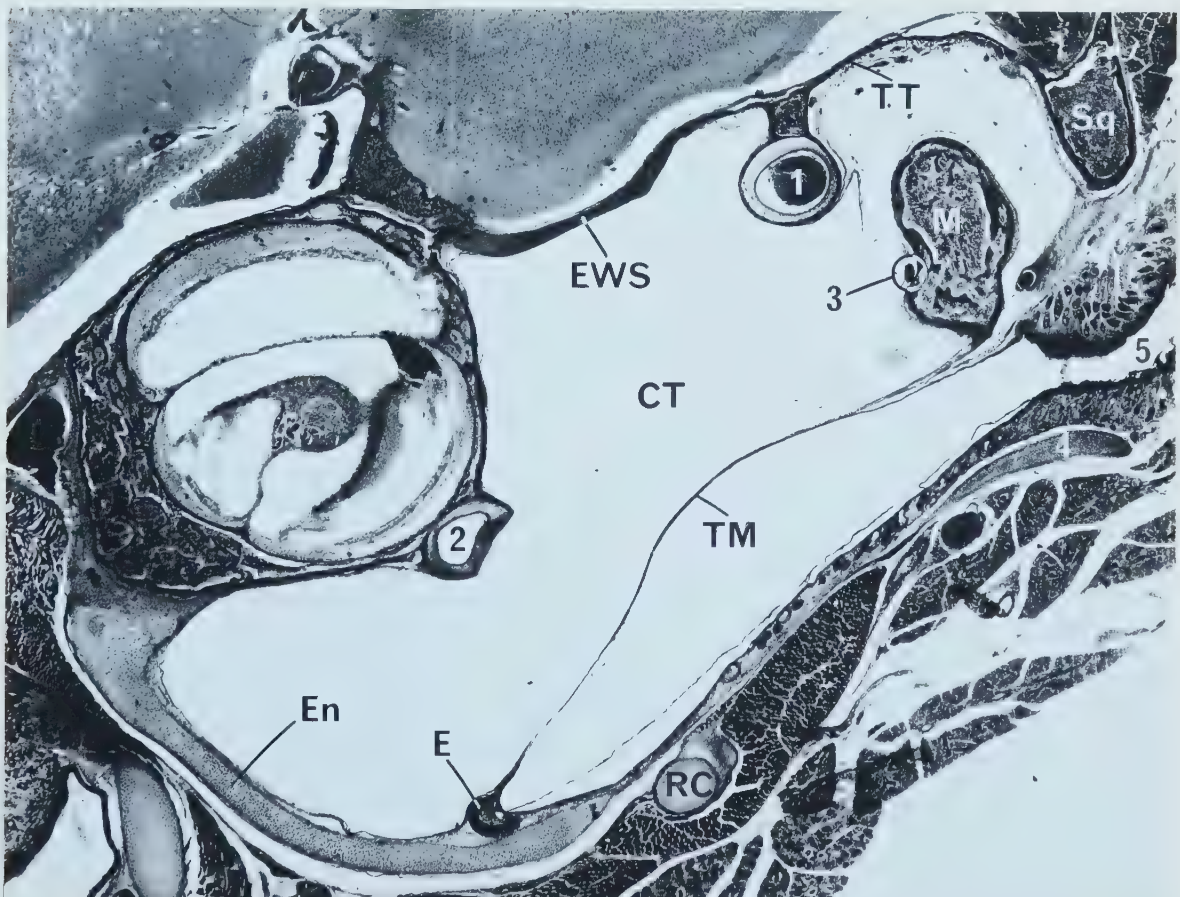
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FIG. IV-11 *T. glis* MPIH 1961/11 (adult); s. 2800, cross-section, left side (sides rev.); Azan; x 16.

Growth of the entotympanic V. The definitive, bony bulla forms a shell around the large hypotympanic sinus.

1, promontorial a.; 2, stylohyal; 3, crest on petrosal (?RTPP); 4, (proximal) stapedial a.; 5, malleus (displaced during processing); 6, auricular cartilage.

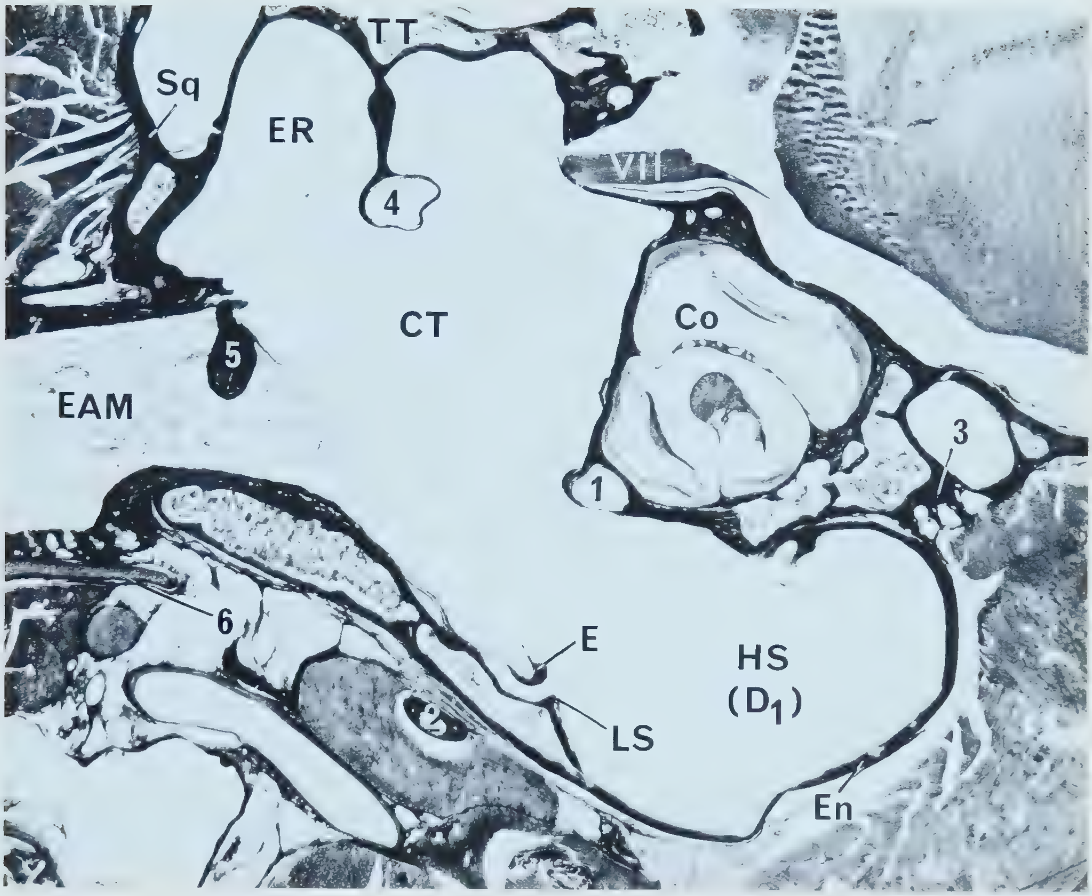

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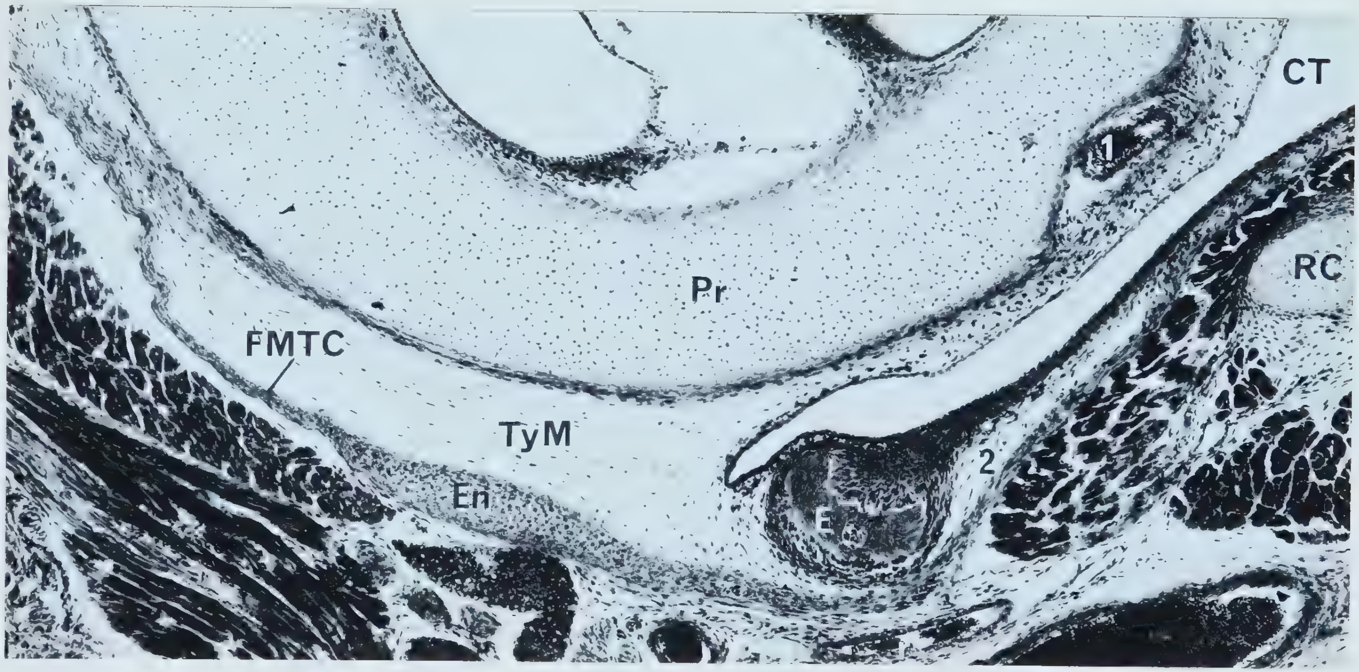
FIG. IV-12 *T. glis* MPIH 1959/4 (newborn); s. 322/1, cross-section, right side (sides rev.); Azan; x 90.

Relationship of the ectotympanic and entotympanic I. The entotympanic (here represented by its caudal spur) is embedded within the well-developed fibrous membrane of the tympanic cavity, but it has not yet grown around the ectotympanic. Note that the fibrous membrane is not connected to the periosteum of the ectotympanic.

1, promontorial a. and internal carotid n.; 2, presumptive tissues of membranous meatus; 3, tunica mucosa; 4, definitive membranous meatus.


CT
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FMTC
TyM
2
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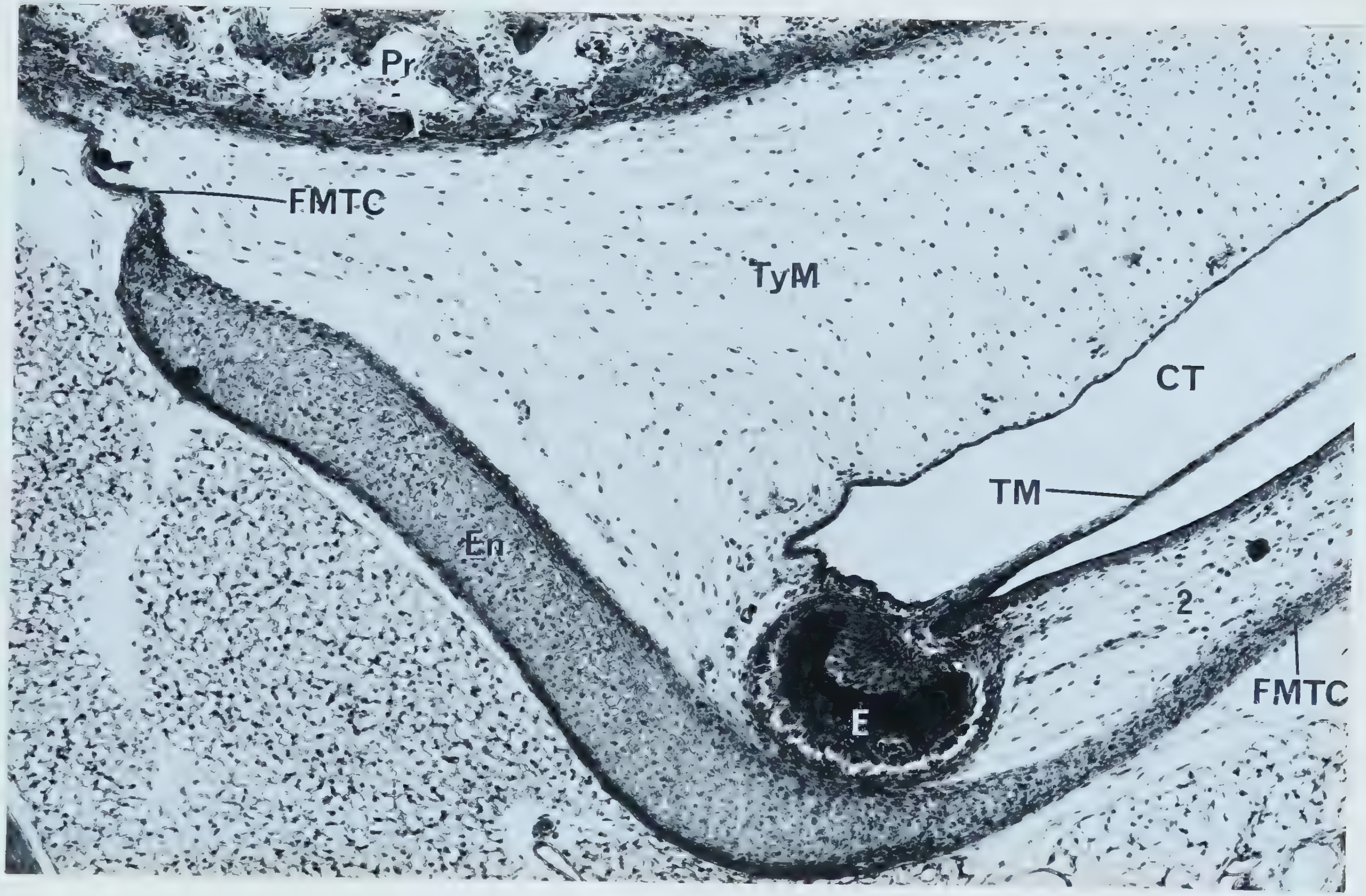
E

601

FIG. IV-13 *T. glis* MPIH 1960/77 (8 days old); s. 1330, cross-section, left side; Azan; x 113.

Relationship of the ectotympanic and entotympanic II. This is an enlargement if fig. IV-9. The entotympanic, growing within the fibrous membrane, has passed beneath the ectotympanic. Note the complete absence of sutural tissues.

For key to numbered structures, see fig. IV-12.

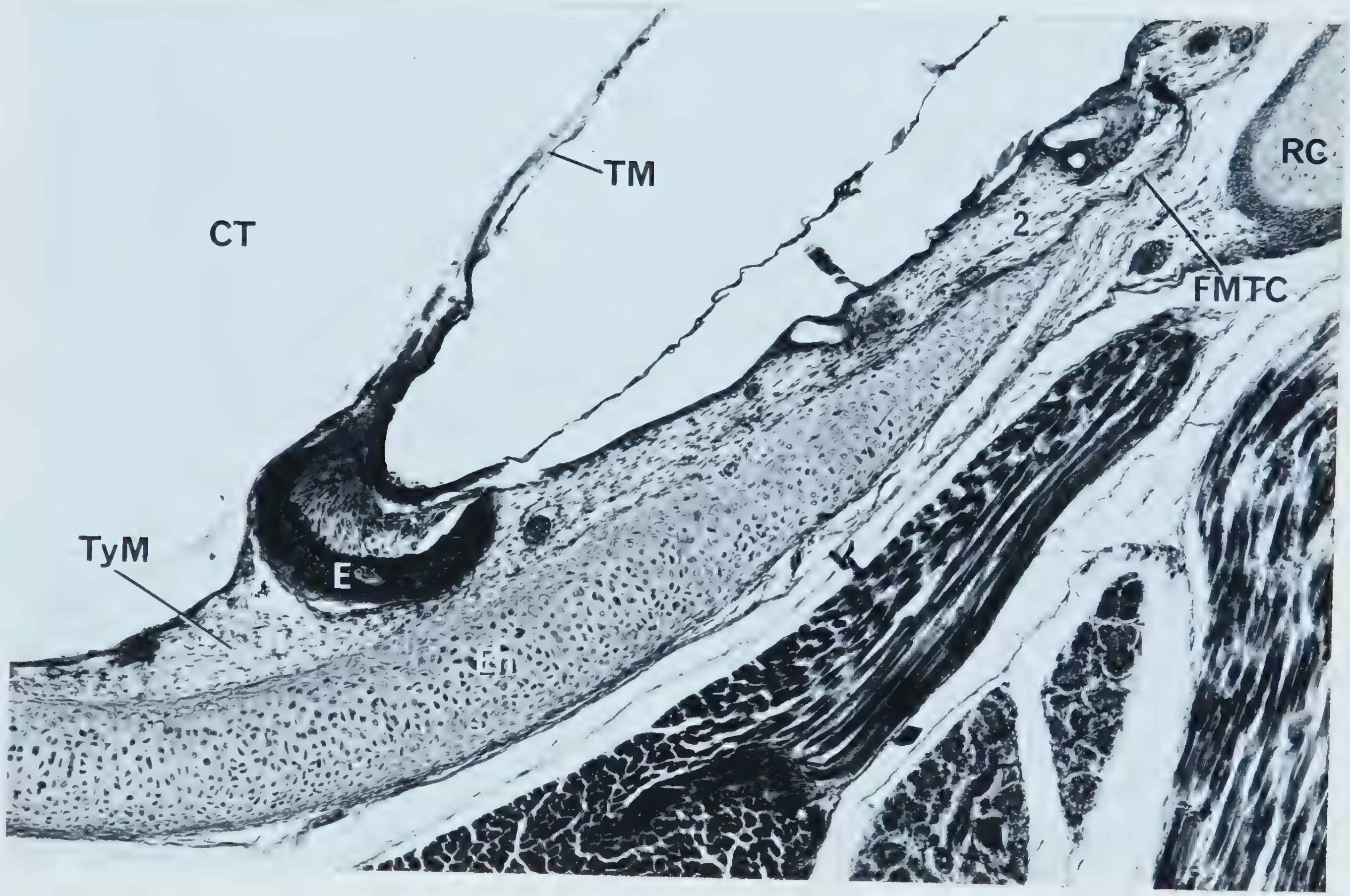

FMTC
2
CT
TM
E
TyM
En
Pr
FMTC

603

FIG. IV-14 *T. glis* MPIH 1964/10 (19 days old); s. 1505, cross-section, left side; Azan; x 115.

Relationship of the ectotympanic and entotympanic III. The entotympanic continues its laterad expansion within the fibrous membrane. As in previous stages, there is no indication of sutural tissues at the ectotympanic-entotympanic interface. Note also that part of the presumptive tissue of the membranous meatus has become 'intrabullar' along with the ectotympanic.

For key to numbered structures, see fig. IV-12.


TM
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TyM
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605

FIG. IV-15 *T. glis* MPIH 1961/11 (adult); s. 2770, cross-section, left side; Azan; x 175.

Relationship of the ectotympanic and entotympanic IV. Although there is some disruption of soft tissues, it is clear that the ectotympanic is connected to the bullar wall by means of the tissues of the tunica mucosa and the membranous meatus. No independent 'anulus membrane' or true sutural tissues are in evidence.

For key to numbered structures, see fig. IV-12.


TM
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607

FIG. IV-16 *T. glis* MPIH 1960/82a (near-term fetus); s. 940, cross-section, right side (sides rev.); Azan; x 32.

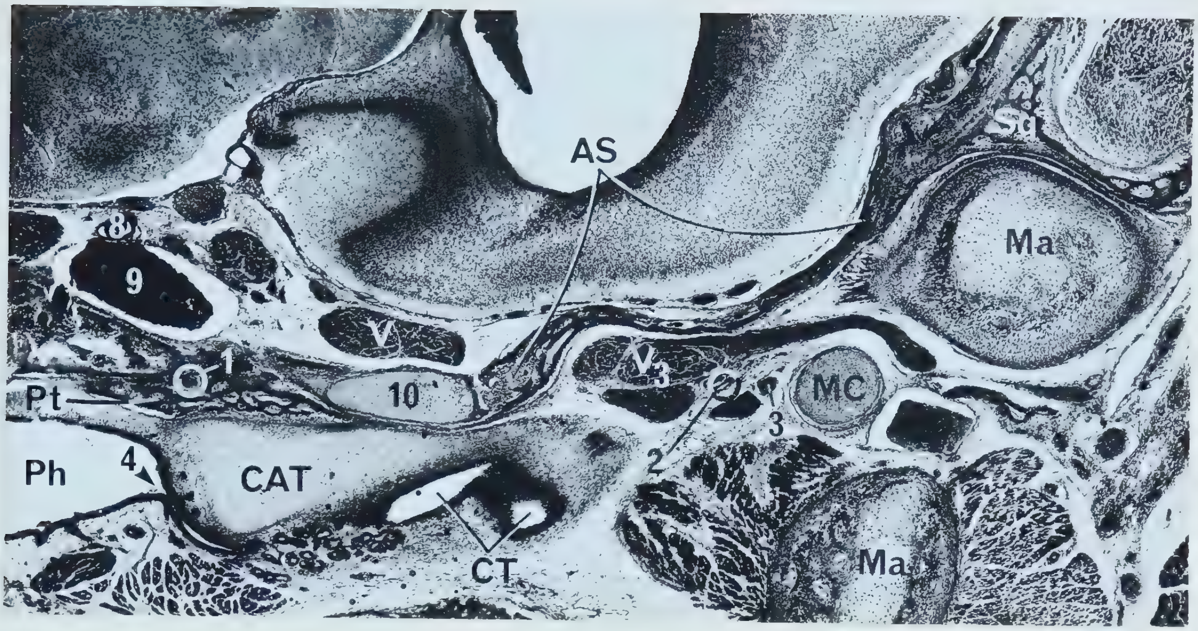
Section through pharyngeal end of auditory tube. Comparisons with adult conditions (cf. fig. IV-38a,b) suggests that the rostral part of the homogeneous anterior mass of cartilage eventually becomes the (true) cartilage of the auditory tube. However, at this stage there is no histological difference between this section and the rest of the anterior mass (cf. figs. IV-17, IV-18).

For key to numbered structures, see fig. IV-17.

FIG. IV-17 *T. glis* MPIH 1960/82a (near-term fetus); s. 960, cross-section, right side (sides rev.); Azan; x 32.

Anterior end of presumptive tympanic cavity. This section reveals the complicated shape of the anterior mass of cartilage immediately posterior to the level of the auditory tube (cf. fig. IV-16). On morphological grounds, this section of the anterior mass is probably composed of entotympanic material alone. It contains the rostral end of the medial diverticulum (D_2) of the hypotympanic sinus and the anterior septum, both of which are enclosed or formed by the entotympanic in the adult (fig. IV-3).

1, nerves of the pterygoid canal; 2, ramus inferior of the stapedial a.; 3, chorda tympani, 4, auditory tube; 5, diverticulum D_2; 6, lesser petrosal n.; 7, anterior septum; 8, promontorial a. (cerebral carotid a.) within cranial cavity; 9, cavernous sinus; 10, ala temporalis.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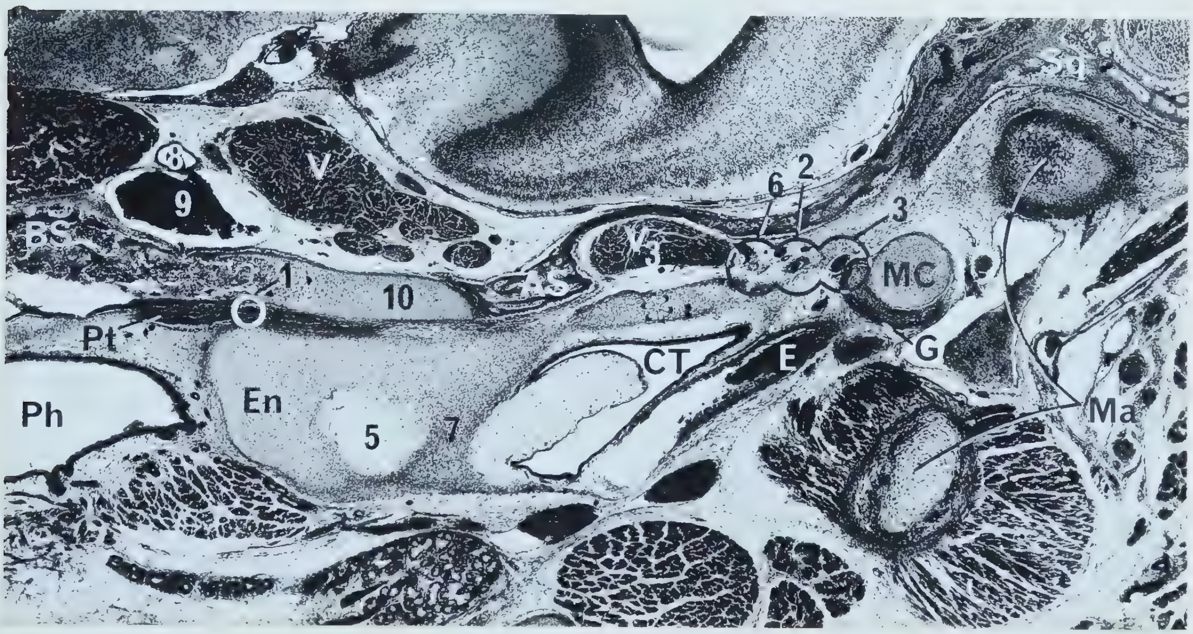
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FIG. IV-18 *T. glis* MPIH 1960/82a (near-term fetus); x. 1000, cross-section, right side (sides rev.); Azan; x 32.

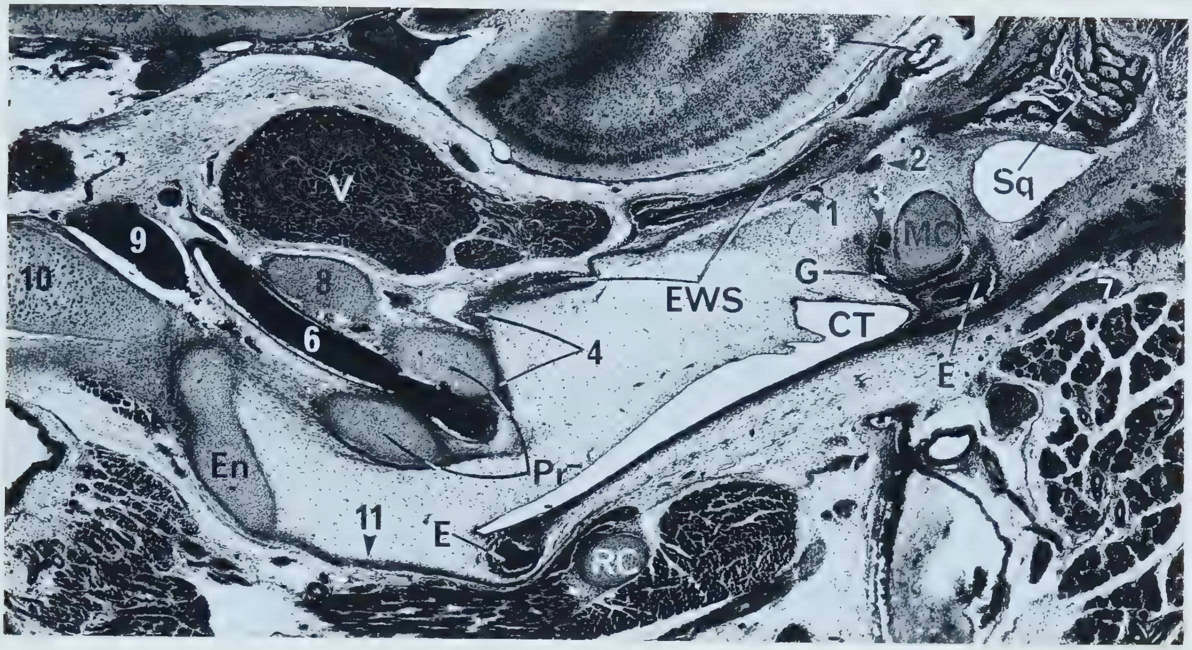
Section through foramen caroticum primitivum and anterior pole of promontory. The entotympanic continues a short distance further in the medioventral wall of the presumptive tympanic cavity.

For key to numbered structures, see fig. IV-19.

FIG. IV-19 *T. glis* MPIH 1960/82a (near-term fetus); s. 1010, cross-section, right side (sides rev.); Azan; x 32.

Terminal part of the entotympanic. The entotympanic ends within the fibrous membrane of the tympanic cavity immediately posterior to the level of the anterior pole of the promontory at this stage.

1, lesser petrosal n.; 2, ramus inferior of stapedial a.; 3, chorda tympani; 4, deep and greater petrosal nn. (nerves of the pterygoid canal); 5, ramus superior of the stapedial a. (middle meningeal a.); 6, promontorial a.; 7, auricular cartilage; 8, alicochlear commissure; 9, cavernous sinus; 10, basioccipital-basisphenoidal synchondrosis; 11, FMTC.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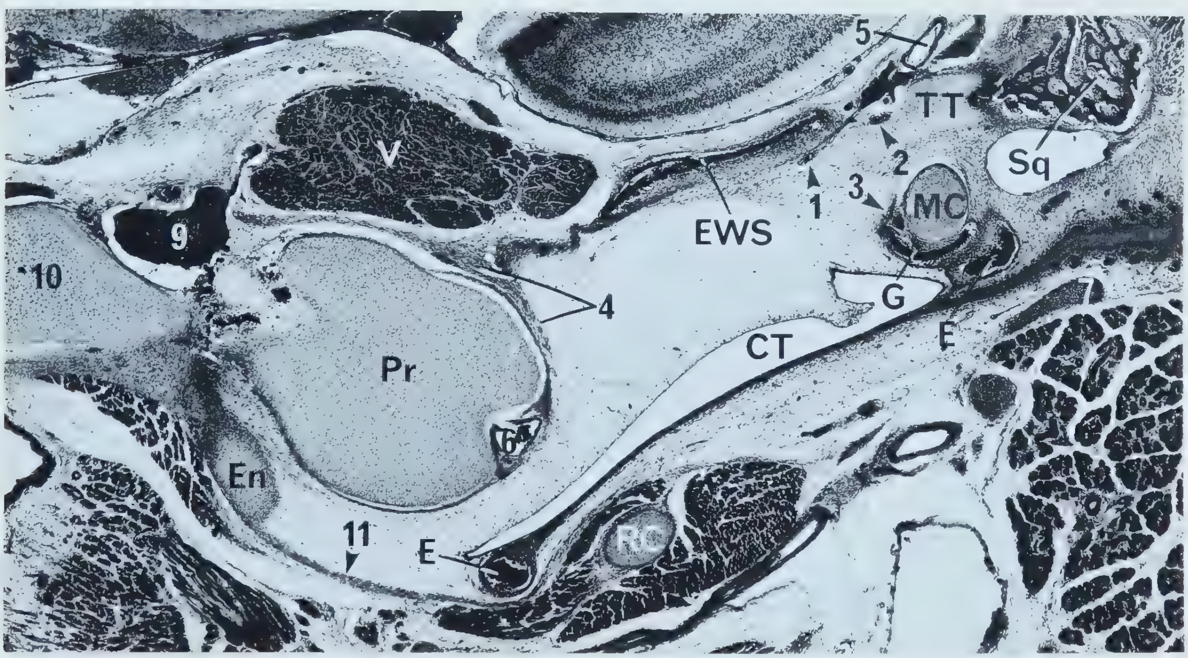
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611

FIG. IV-20 *T. glis* MPIH 1960/82a (near-term fetus); s. 1120, cross-section, right side (sides rev.); Azan; x 32.

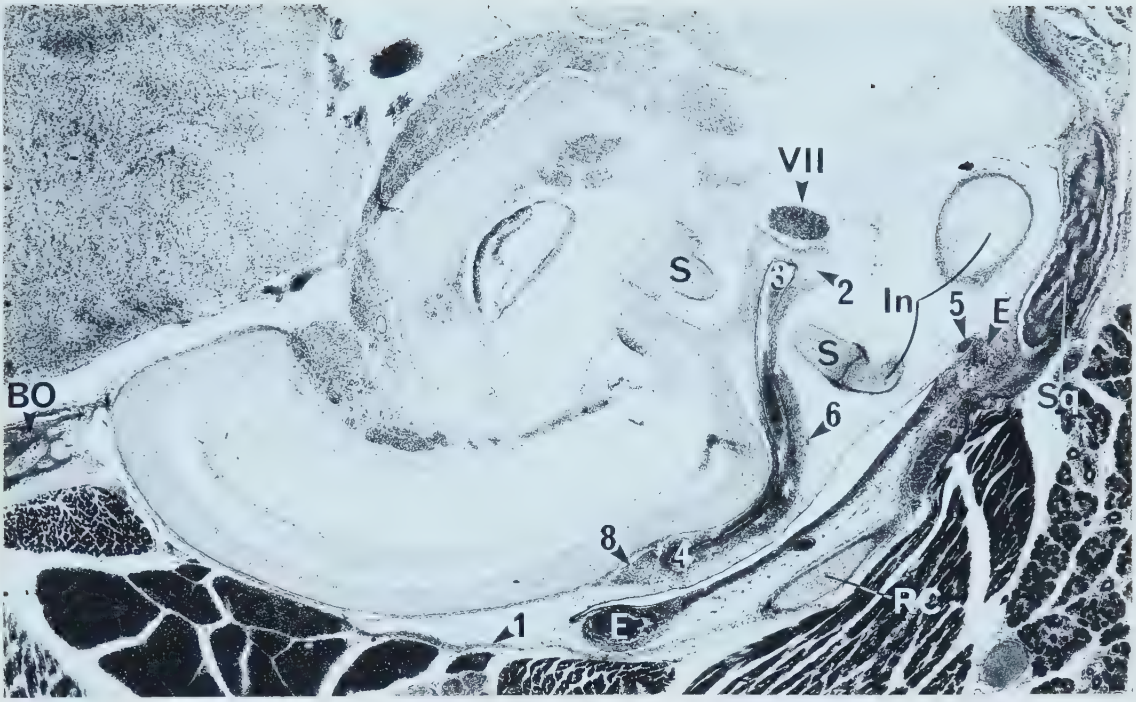
Bifurcation of the internal carotid cartery into promontorial and (proximal) stapedial branches. The cartilage of the tegmen tympani migrates along the stapedial artery, eventually forming a complete canal around the vessel.

For key to numbered structures, see fig. IV-21.

FIG. IV-21 *T. glis* MPIH 1960/82a (near-term fetus); s. 1140, cross-section, right side (sides rev.); Azan; x 32.

Entry of the internal carotid artery and nerve into the middle ear. The processes recessus does not contribute, or only very little, to the bulla (cf. lorises and lemurs, figs. II-1, III-1). The anterior end of the caudal tympanic process of the petrosal (12) is confluent with the medial wall of the facial sulcus.

1. FMTC; 2, cartilage of the stapedial canal; 3, (proximal) stapedial artery; 4, promontorial a.; 5, chorda tympani; 6, tympanic nerve (major branch); 7, stapedius m.; 8, internal carotid n.; 9, internal carotid a.; 10, perilymphatic duct; 11, secondary tympanic membrane; 12, anterior end of CTPP.



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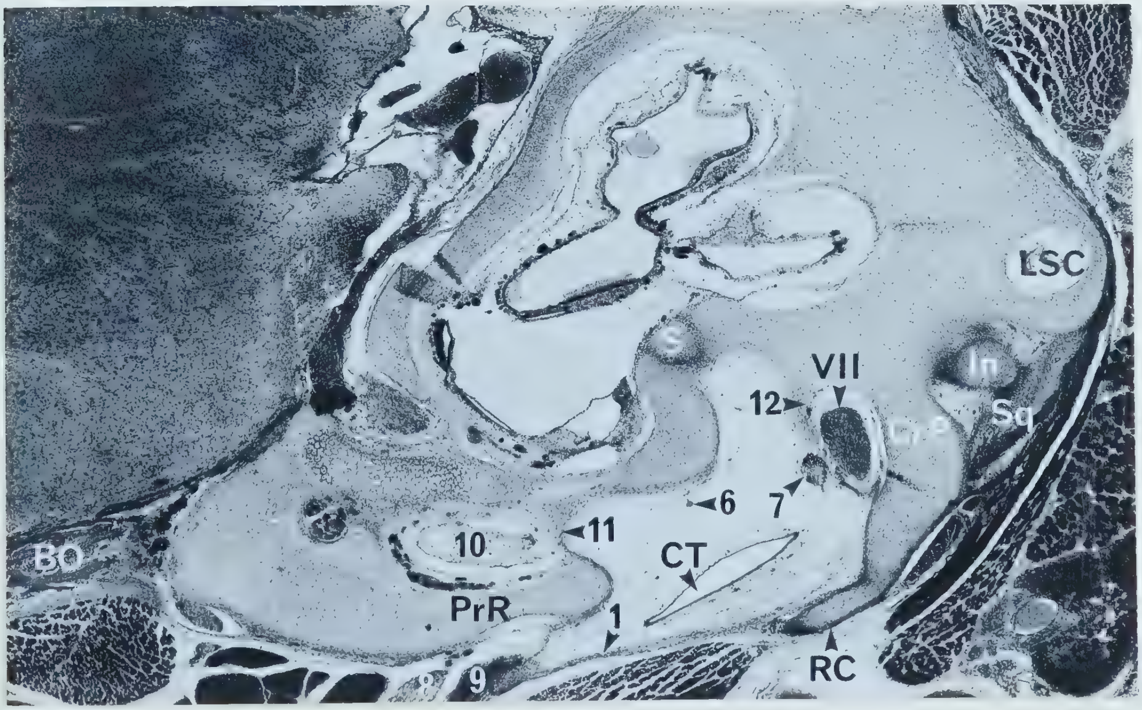

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FIG. IV-22 *T. glis* MPIH 1960/82a (near-term fetus); s. 1160, cross-section, left side; Azan; x 46.

Middle part of the caudal tympanic process of the petrosal. The process forms, with the posterior continuation of the crista parotica, a deep fossa for the stapedius muscle.

1, stapedius m.; 2, tympanic n. (major branch); 3, posterior continuation of the crista parotica beneath the prominence of the lateral semicircular canal; 4, FMTC; 5, auricular ramus of the vagus n.; 6, part of the facial n.

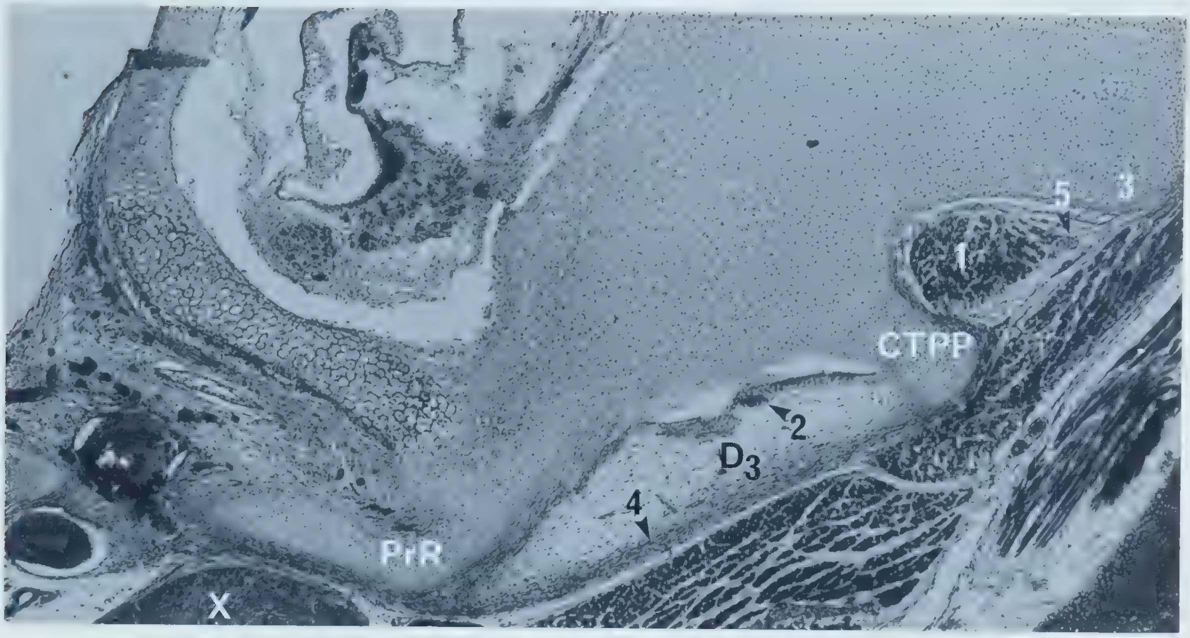
FIG. IV-23 *T. glis* MPIH 1960/82a (near-term fetus); s. 1170, cross-section, left side; Azan; x 56.

Posterior part of the caudal tympanic process of the petrosal. In lemurs and lorises (cf. figs. II-16, III-19), the posterior continuation of the crista parotica is incorporated into the lateral part of the CTPP. In tree shrews, the lateral part of the CTPP forms medial to the stapedius muscle, and the posterior continuation of the crista parotica does not take part in the construction of the bulla.

For key to numbered structures, see fig. IV-22.

FIG. IV-24 *T. glis* MPIH 1959/4 (newborn); s. 304/1, cross-section, left side; Azan; x 22.

Anterior end of presumptive tympanic cavity (cf. fig. IV-17).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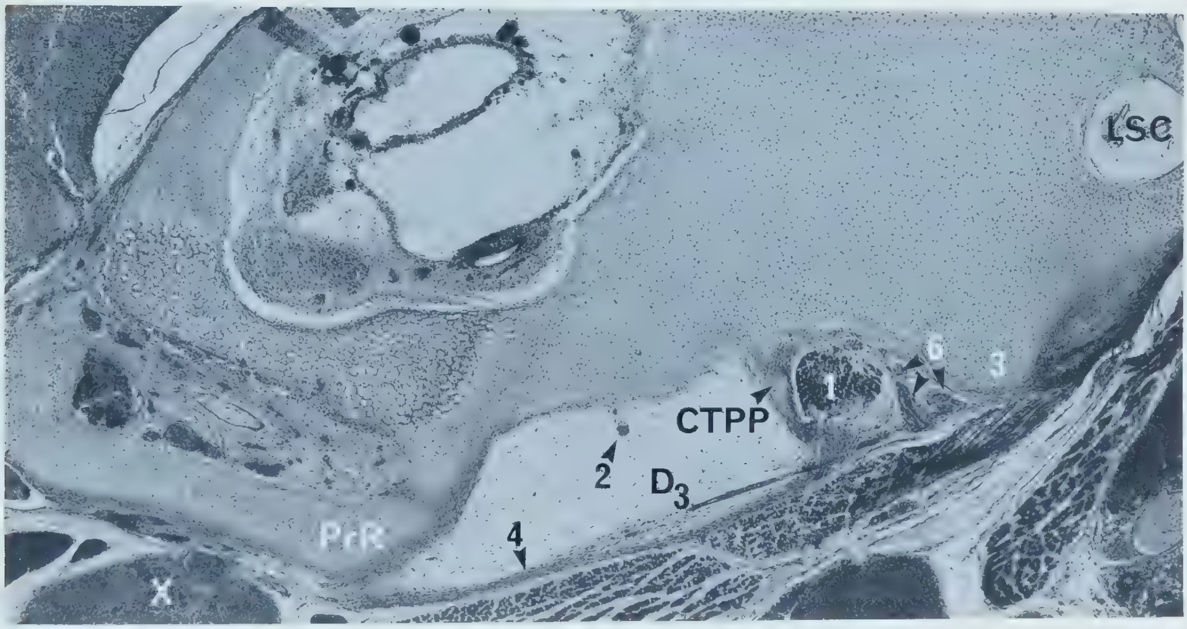
PrR
X


LSC
6
3
1
CTPP
2
D_3
4
PrR
X

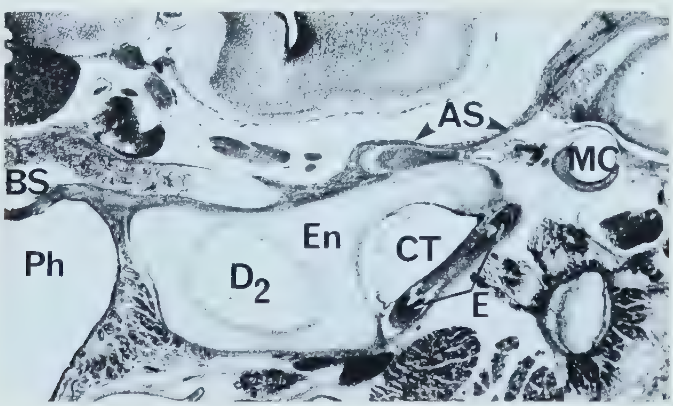
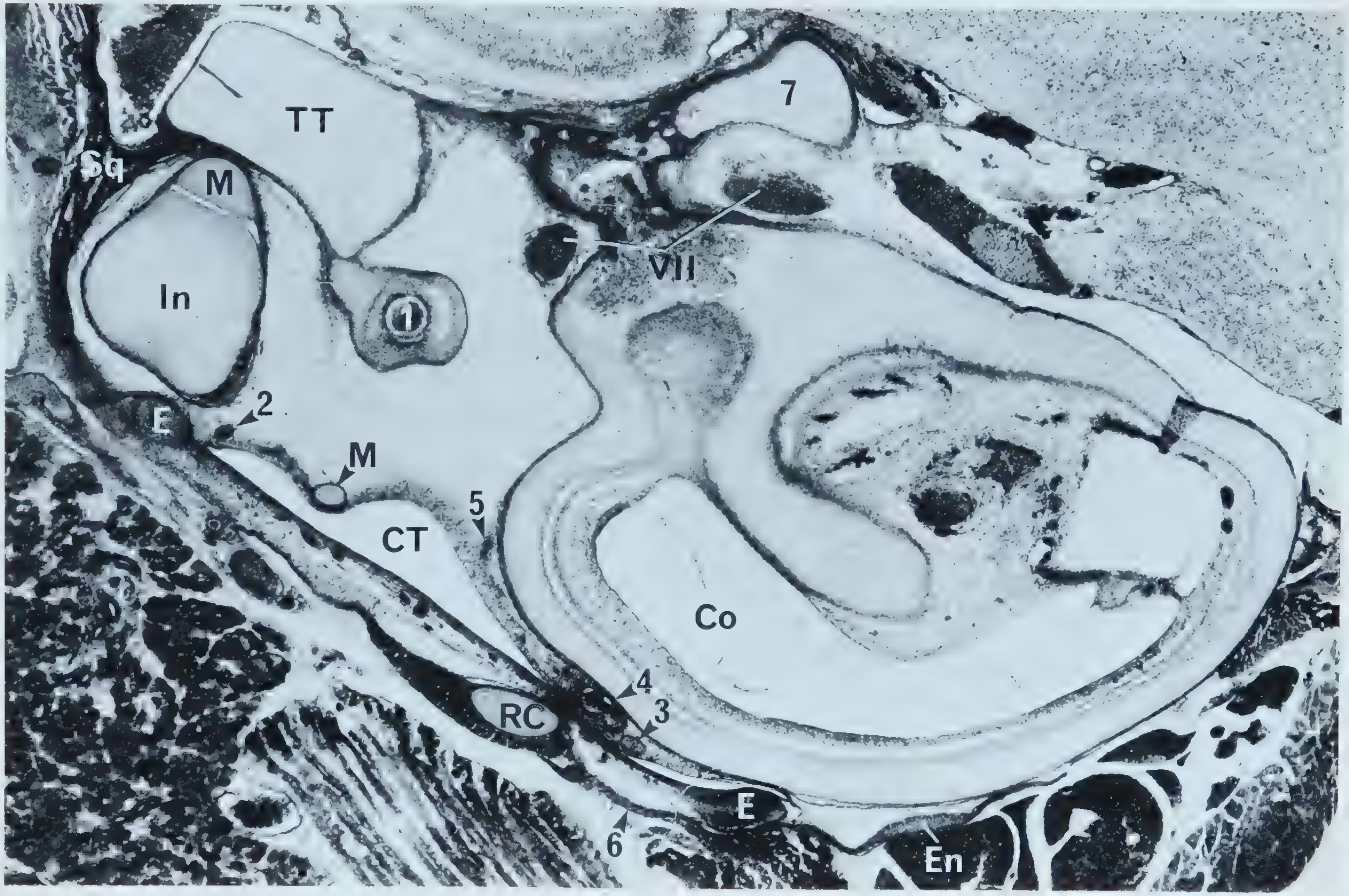

AS
MC
BS
Ph
En
CT
D_2
E

FIG. IV-25 *T. glis* MPIH 1959/4 (newborn); s. 345/2, cross-section, right side; Azan; x 33.

Middle of the presumptive tympanic cavity. Note small size of epitympanic recess (containing incudomalleolar joint) and the complete, cartilaginous canal for the (proximal) stapedial artery.

1, (proximal) stapedial a.; 2, chorda tympani; 3, internal carotid n.; 4, promontorial a.; 5, tympanic nerve (major branch); 6, FMTC; 7, suprafacial commissure.


TT
7
Sq
M
VII
In
1
2
E
M
5
CT
Co
4
RC
3
E
6
En

617

FIG. IV-26 *T. glis* MPIH 1959/4 (newborn); s. 360/4, cross-section, right side (sides rev.); Azan; x 30.

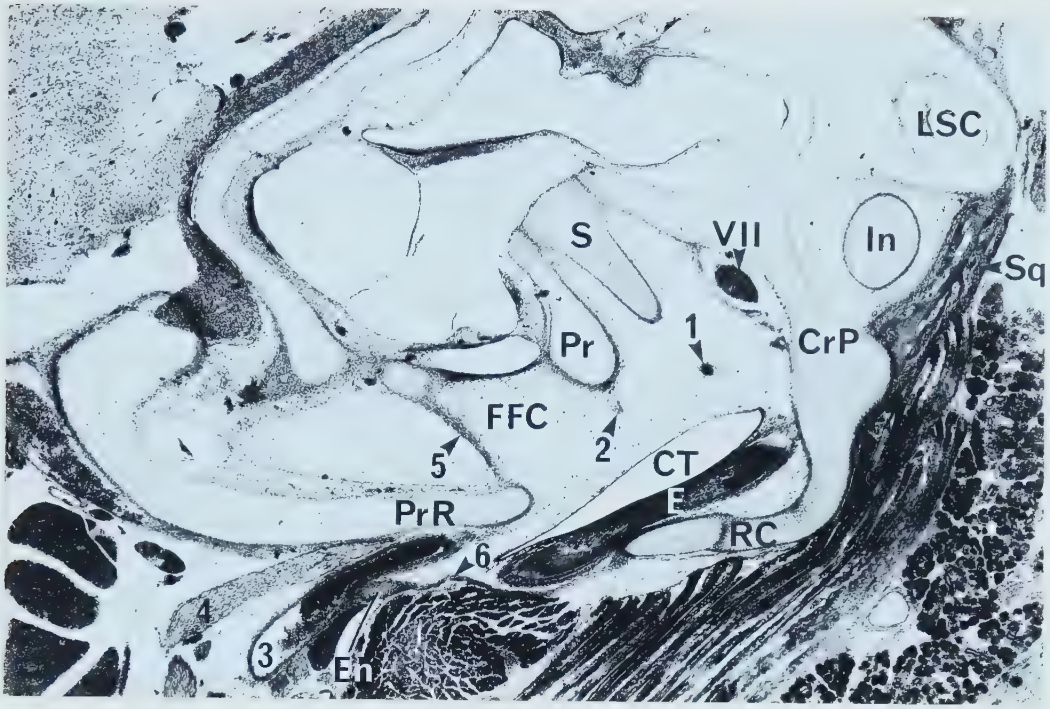
Terminal part of entotympanic. The caudal spur ends at the level of the posterior carotid foramen at this stage (cf. fig. IV-1).

1, tendon of stapedius m.; 2, tympanic nerve (major branch); 3, internal carotid a.; 4, internal carotid n.; 5, secondary tympanic membrane; 6, FMTC.

FIG. IV-27 *T. glis* MPIH 1959/4 (newborn); s. 378/4, cross-section, left side; Azan; x 41.

Posterior part of caudal tympanic process of the petrosal (cf. fig. IV-24).

1, stapedius m. in stapedius fossa; 2, tympanic n. (major branch) entering D_3 through FMTC; 3, FMTC; 4, auricular ramus of vagus n.; 5, posterior continuation of crista parotica.


LSC
S
VII
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Sq
Pr
1
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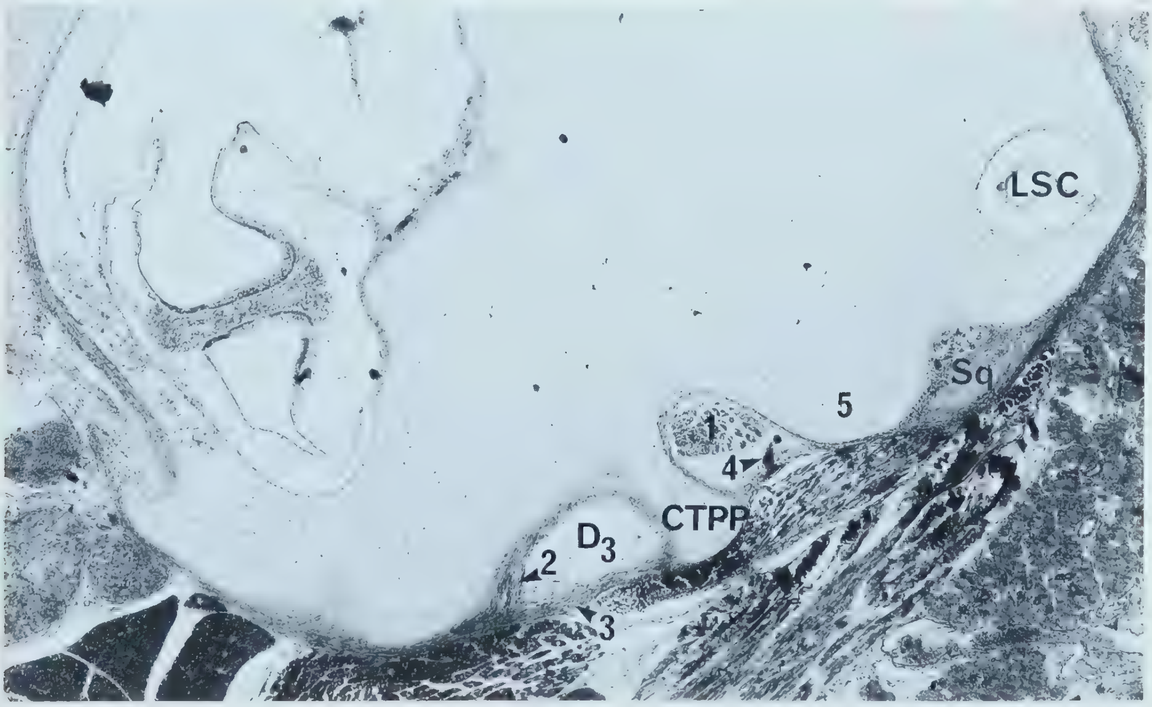
FFC
2
5
CT
E
PrR
RC
6
4
3
En


LSC
Sq
5
1
4
CTPP
D3
2
3

6|9

FIG. IV-28 _T. glis_ MPIH 1960/77 (8 days old); s. 1145, cross-section, left side; Azan; x 30.

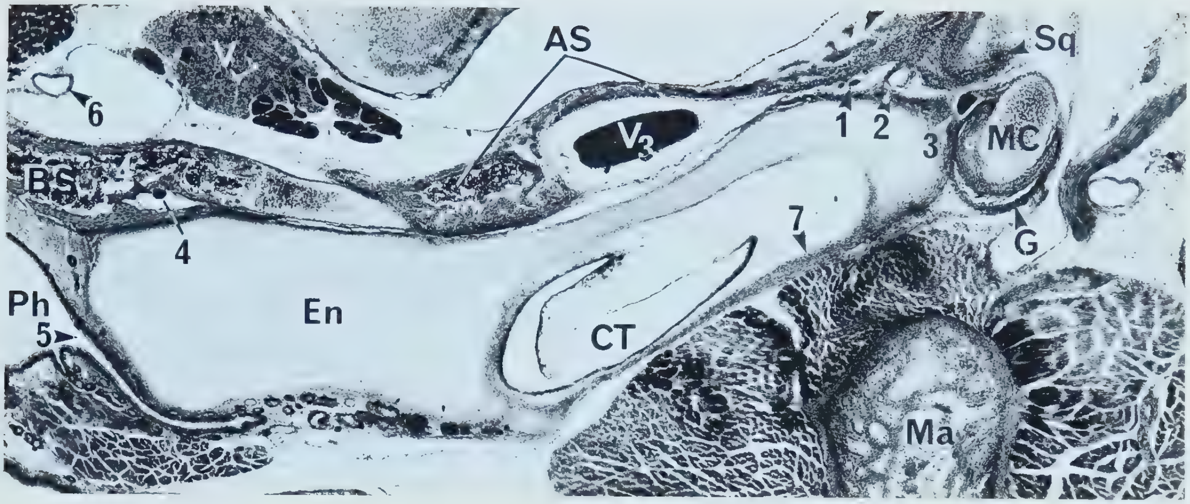
There is still no histological difference between the material of the entotympanic and that of the cartilage of the auditory tube. In this section, the material immediately adjacent to the auditory tube probably remains cartilaginous (i.e., becomes the definitive cartilage of the tube). The rest may be regarded as the entotympanic (cf. figs. IV-32, IV-38a,b).

1, lesser petrosal n.; 2, ramus inferior of the stapedial a.; 3, chorda tympani; 4, nerves of the pterygoid canal; 5, auditory tube (lumen); 6, promontorial a. (cerebral carotid a.); 7, FMTC.

FIG. IV-29 _T. glis_ MPIH 1960/77 (8 days old); s. 1190, cross-section right side (sides rev.); Azan; x 31.

The complicated relationships of septa and diverticula in the anterior part of the tympanic cavity are well displayed in this young postnatal specimen. The entotympanic and anterior end of the tegmen tympani are fused by means of a commissure (see fig. IV-2).

1, promontorial a. (cerebral carotid a.); 2, alicochlear commissure; 3, nerves of the pterygoid canal; 4, lesser petrosal nerve in its canal; 5, ramus superior of the stapedial a.; 6, entotympanic-tegminal commissure; 7, chorda tympani; 8, innominate diverticulum; 9, lateral secondary septum.


AS
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V3
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MC
BS
4
7
G
Ph
En
5
CT
Ma


5
V
AS
4
TT
Sq
1
V3
7
MC
2
3
6
G
E
8
9
D2
CT
En
E
Ma

621

FIG. IV-30 *T. glis* MPIH 1960/77 (8 days old); s. 1215, cross-section, left side; Azan; x 28.

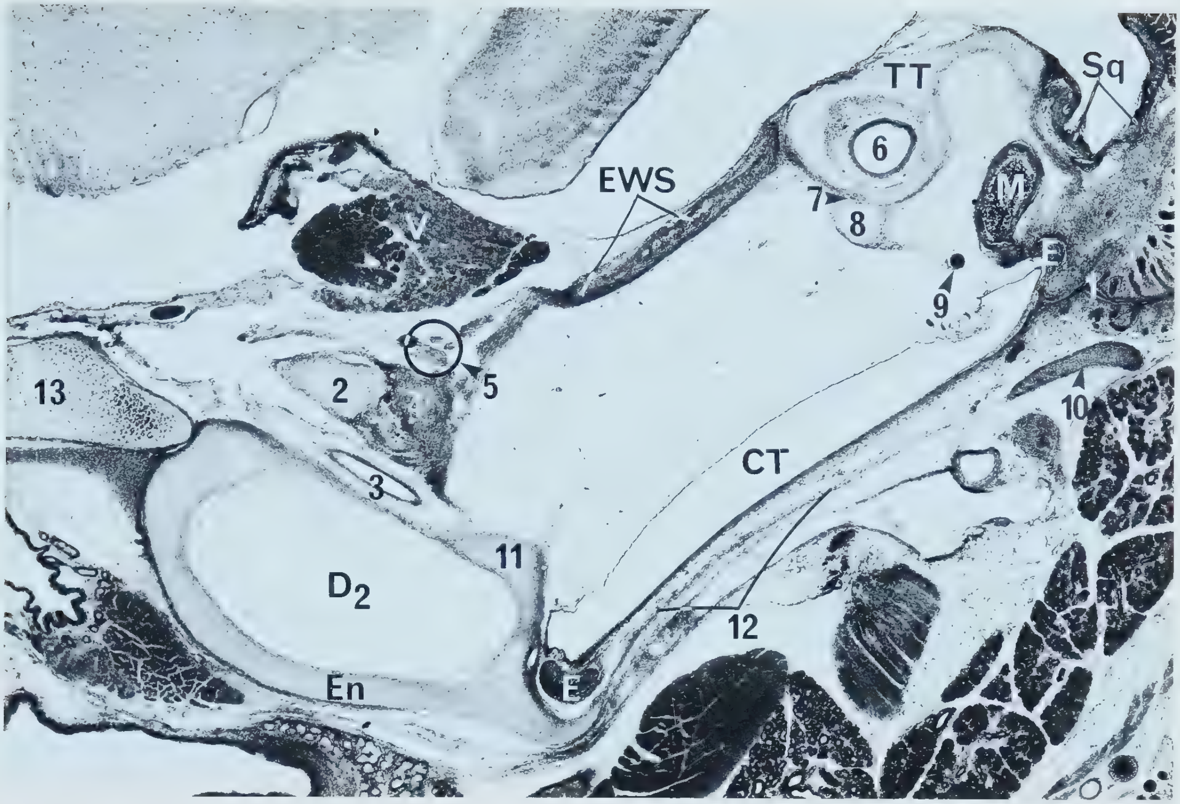
The anterior septum has reached the anterior pole of the promontory by this stage and forms part of the eventual canal for the promontorial artery. The alicochlear commissure is in the process of degeneration. Also illustrated is the extreme posterior end of the entotympanic-tegminal commissure; note that the fusion of the two structures is not complete in this region.

1, lumen of the external acoustic meatus; 2, alicochlear commissure; 3, promontorial a.; 4, anterior pole of the promontory; 5, nerves of the pterygoid canal; 6, (proximal) stapedial a.; 7, lesser petrosal n.; 8, extreme posterior end of entotympanic-tegminal commissure; 9, chorda tympani; 10, auricular cartilage; 11, anterior septum; 12, FMTC; 13, basioccipital-basisphenoidal synchondrosis.

FIG. IV-31 *T. glis* MPIH 1960/77 (8 days old); s. 1410, cross-section, left side; Azan; x 36.

The entotympanic also fuses with the caudal tympanic process of the petrosal.

1, internal carotid n.; 2, internal carotid a.; 3, tympanic n. (communicating branch); 4, tympanic n. (major branch); 5, entotympanic-CTPP commissure; 6, stapedius m. in stapedius fossa.


TT
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EWS
7
8
M
V
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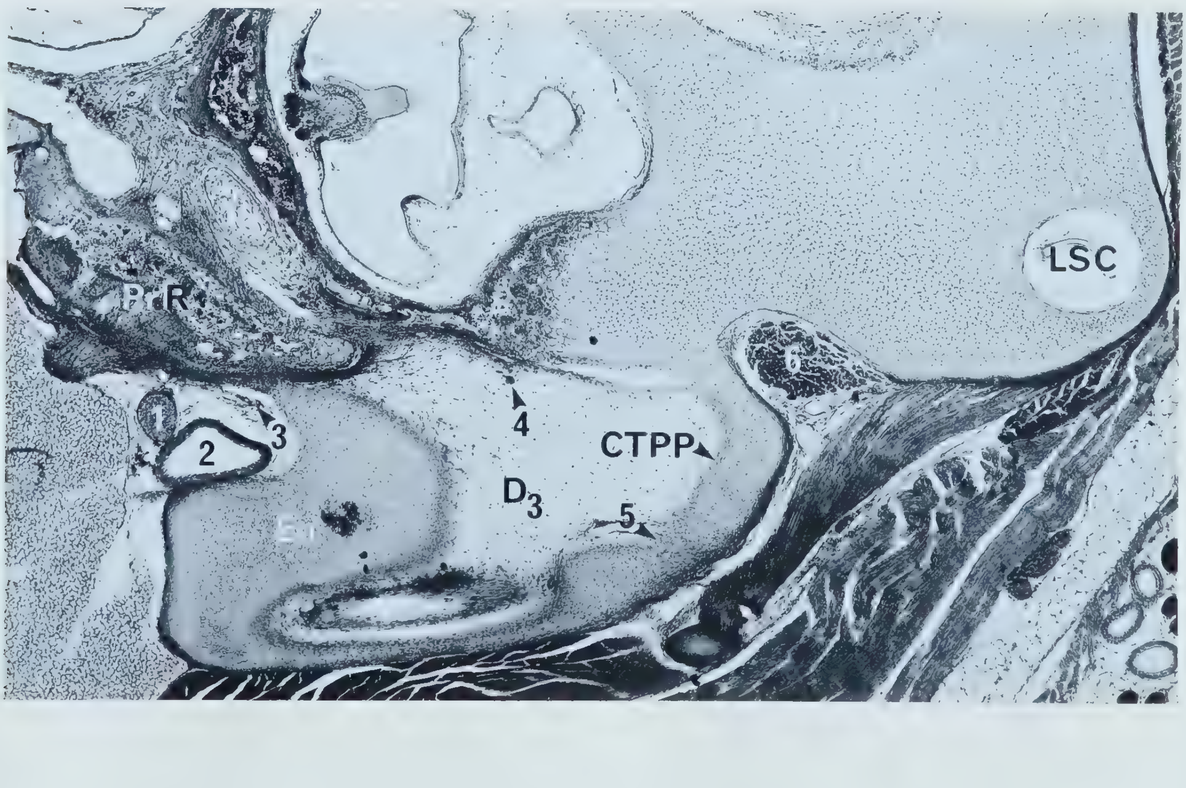
9
5
13
2
10
CT
3
11
D_2
12
En
E


LSC
PrR
6
1
3
2
4
CTPP
D_3
5
En

623

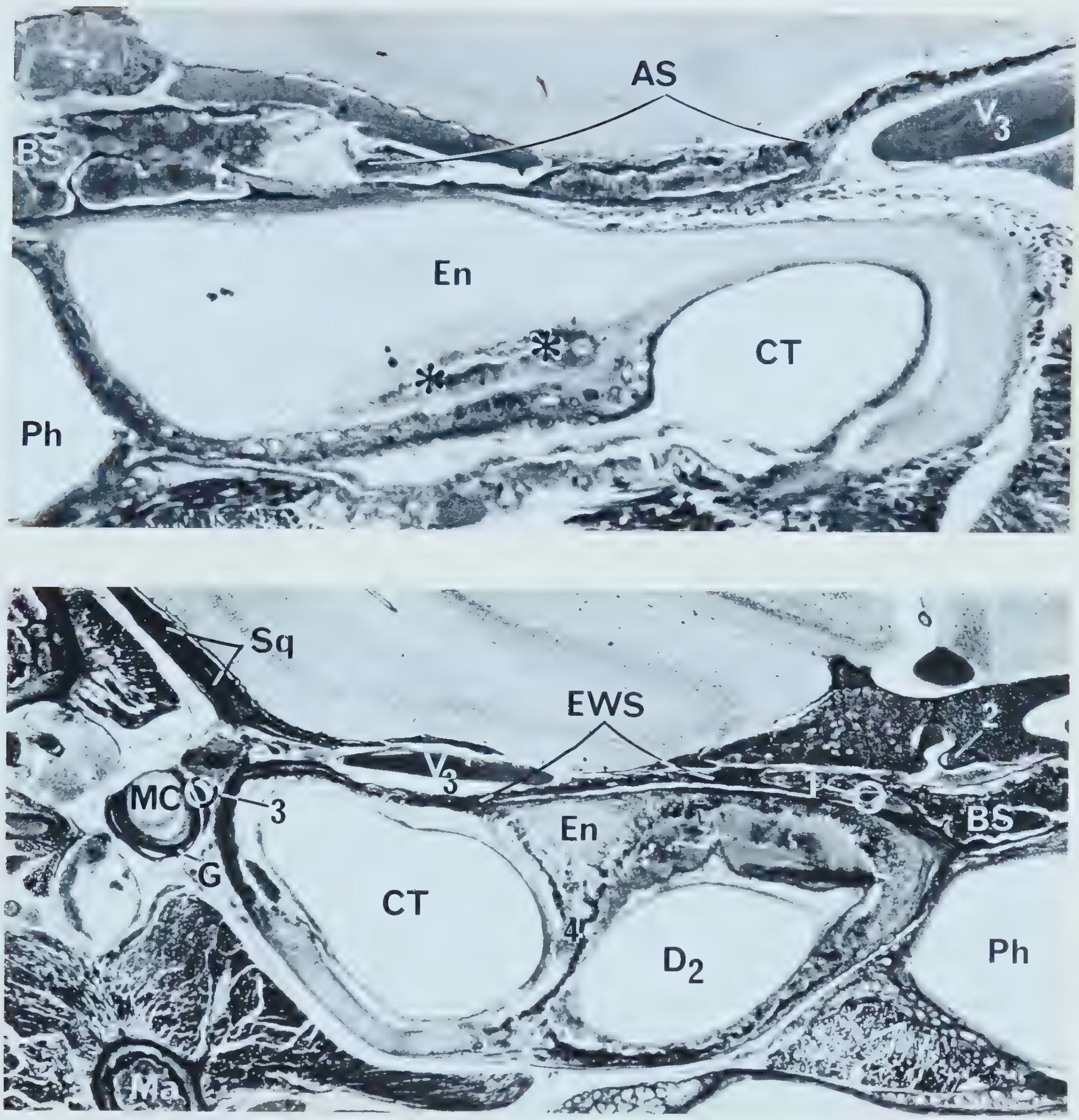
FIG. IV-32 *T. glis* MPIH 1964/10 (19 days old); s. 1270, cross-section, left side; Azan; x 43.

It is still not clear, even at this late stage, how much of the anterior mass of cartilage becomes true tubal cartilage. However, at least an incipient division is now indicated: included in this section is the rostralmost extent of the ossification center of the entotympanic (see also figs. IV-33, IV-34). Bony areas are indicated by asterisks.

FIG. IV-33 *T. glis* MPIH 1964/10 (19 days old); s. 1300, cross-section, right side; Azan; x 17.

The anterior parts of the entotympanic are now extensively ossified.

1, nerves of the pterygoid canal; 2, promontorial a. (cerebral carotid a.); 3, chorda tympani; 4, anterior septum.



AS
BS
V_3
En
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*
CT
Ph
Sq
EWS
2
V_3
MC
3
1
BS
En
G
CT
4
D_2
Ph
Ma

FIG. IV-34 *T. glis* MPIH 1964/10 (19 days old); s. 1375, cross-section, left side (sides rev.); Azan; x 17.

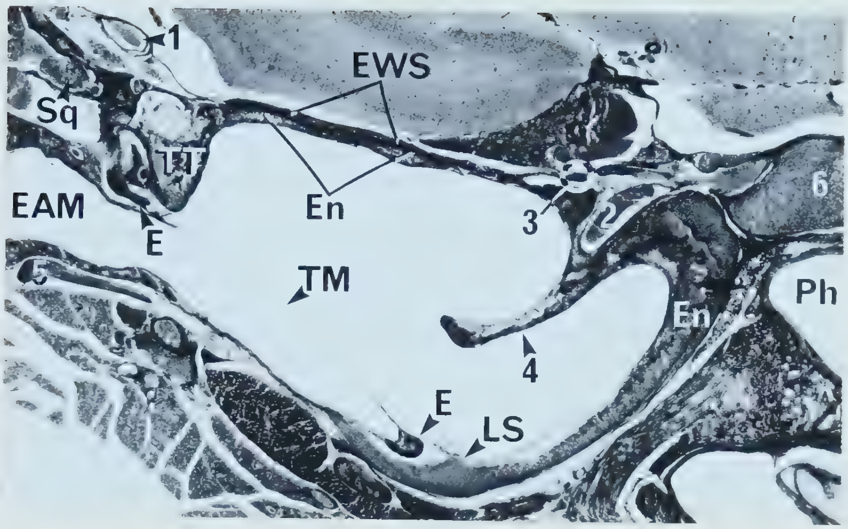
The entotympanic is highly ossified in the area of the anterior septum, which suggests that its center first appears near this feature. Although it is not evident in this figure because of the low degree of magnification, the dorsal part of the entotympanic extends beneath the epitympanic wing of the sphenoid, hiding it from the ventral.

1, ramus superior of the stapedial a. (as middle meningeal a.); 2, promontorial a. entering cranial cavity; 3, nerves of the pterygoid canal; 4, anterior septum; 5, auricular cartilage; 6, basioccipital-basisphenoidal synchondrosis.

FIG. IV-35 *T. glis* MPIH 1964/10 (19 days old); s. 1570, cross-section, right side (sides rev.); Azan; x 17.

There is never a close association between the entotympanic and Reichert's cartilage during the former's growing phase (see also fig. IV-41). The two abut one another, but are not fused. A small part of the auditory capsule is still exposed between the medial margin of the entotympanic and the basioccipital.

1, cranial cervical ganglion of the autonomic nervous system; 2, internal carotid n.; 3, internal carotid a.; 4, stapedius m.; 5, secondary tympanic membrane; 6, incus; 7, tympanic n. (communicating branch); 8, tympanic n. (major branch).


1
EWS
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EAM
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6
TM
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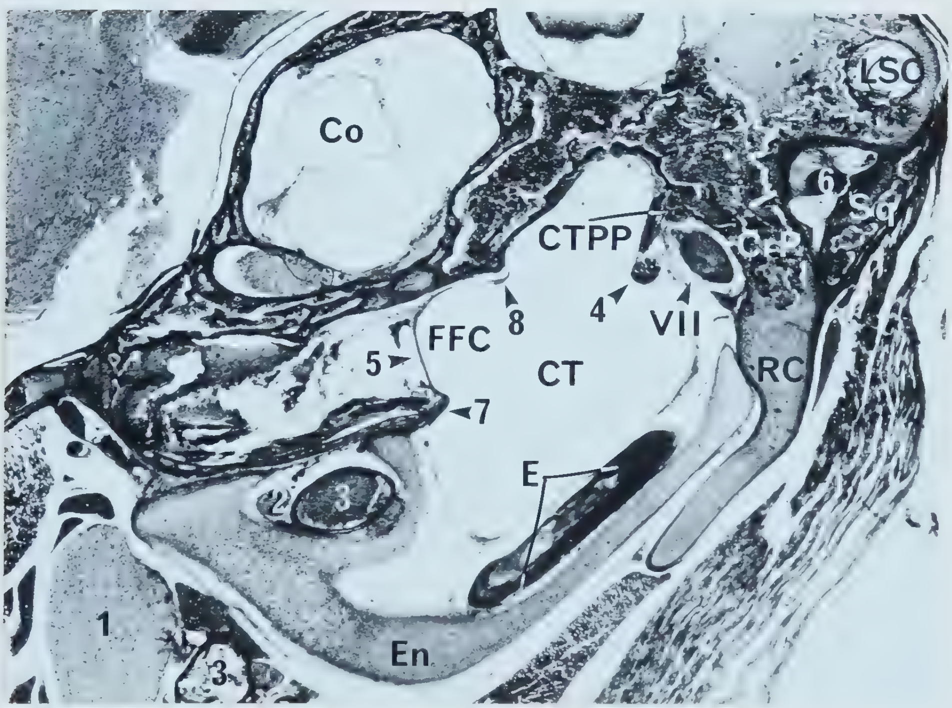
LS


LSC
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6
Sq
CTPP
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VII
8
FFC
5
CT
RC
7
E
2
3
1
En
3

627

FIG. IV-36 *T. glis* MPIH 1964/10 (19 days old); s. 1605, cross-section, left side; Azan; x 50.

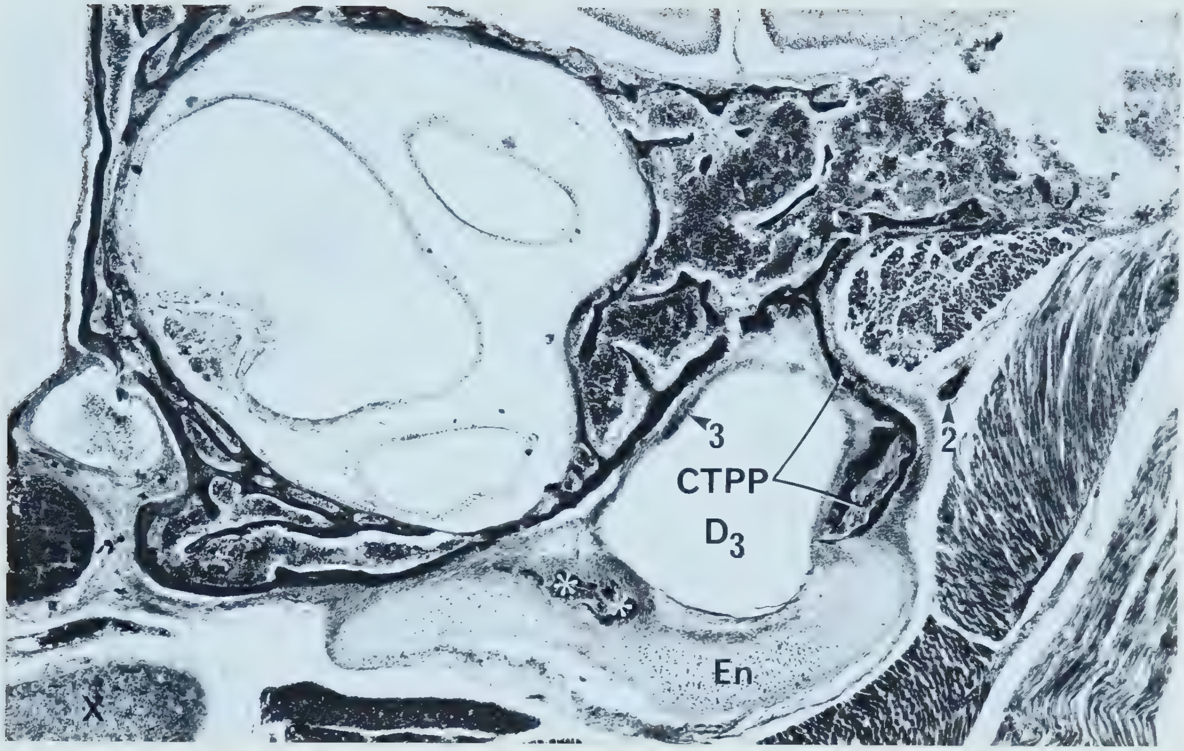
The posterior part of the entotympanic is still cartilaginous, although the caudal tympanic process of the petrosal is fully ossified. In this section, trabeculae of the petrosal seem to extend into the substance of the entotympanic. The area indicated by asterisks consists of bone derived from the caudal tympanic process of the petrosal, not from the entotympanic center further forwards.

1, stapedius m. in stapedius fossa; 2, auricular ramus of the vagus; 3, tympanic n. (major branch).

FIG. IV-37 *T. glis* MPIH 1964/10 (19 days old); s. 1615, cross-section, right side (sides rev.); Azan; x 50.

In this section, the caudal tympanic process of the petrosal is clearly separated from the still-cartilaginous part of the entotympanic by a zone of fibres. The major branch of the tympanic nerve enters diverticulum D_3 through a foramen in the extreme posterior end of the bulla, between the entotympanic and the CTPP (cf. figs. IV-5, IV-27).

For key to numbered structures, see fig. IV-36.


3
2
CTPP
D3
X
En


LSC
1
2
D3
3
CTPP
En

629

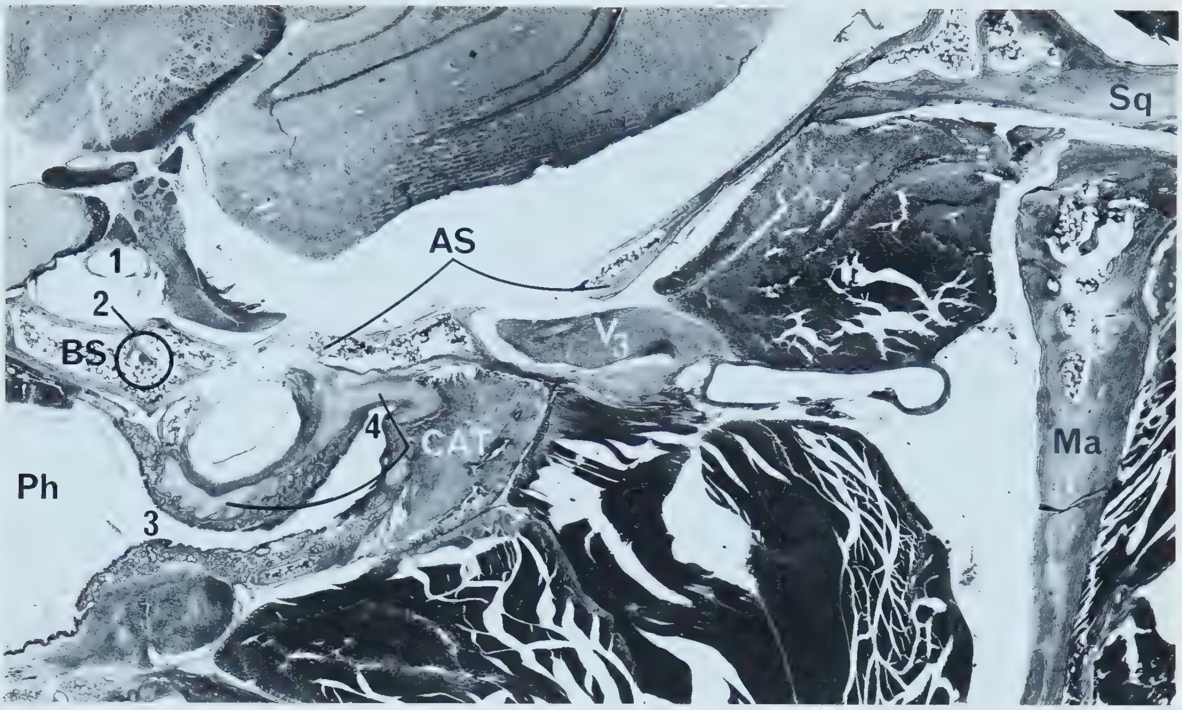
FIG. IV-38 _T. glis_ MPIH 1961/11 (adult).

a. s. 2530, cross-section, left side; Azan; x 15. The cartilage of the auditory tube is quite small in the adult, and does not extend posteriorly beyond the level of the tympanic aperture of the tubal canal.

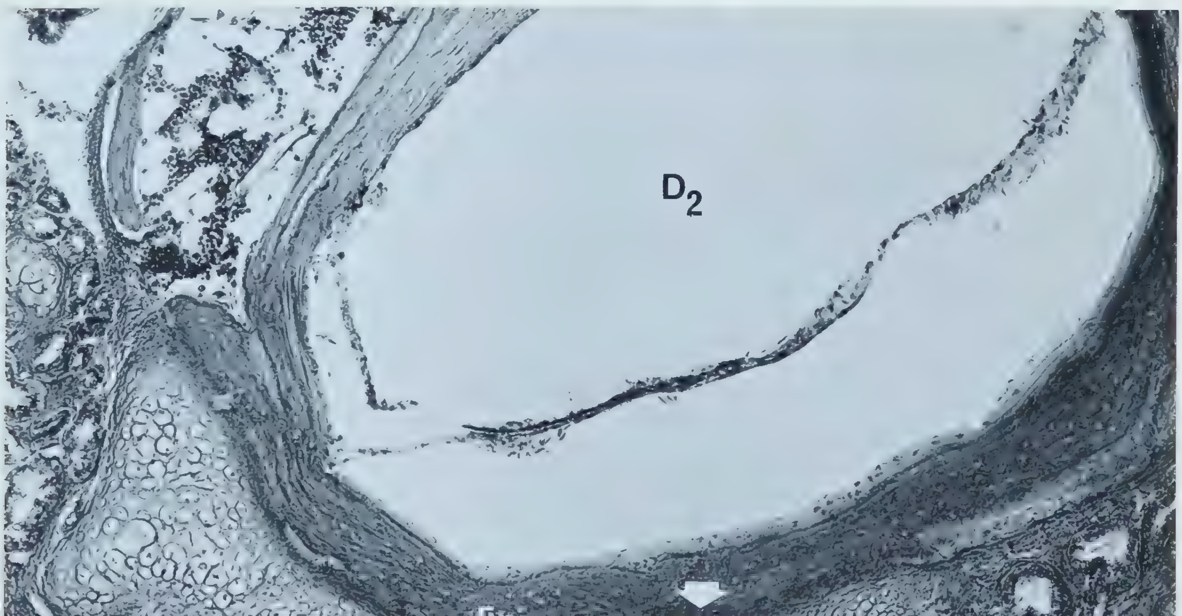
b. same section, enlargement of area in box in fig. IV-38a; x 120. There is no zone of intergradation between the cartilage of the tube and the bone of the entotympanic; the two are separated by dense connective tissues representing their combined perichondrium and periosteum (arrows). This condition implies that there is a real difference between tubal and entotympanic material, even if this cannot be detected histologically in earlier stages.

1, promontorial a. (cerebral carotid a.); 2, nerves of the pterygoid canal; 3, pharyngeal aperture of the auditory tube; 4, tympanic aperture of the auditory tube.

a



b



631

FIG. IV-39 *T. glis* MPIH 1961/11 (adult).

a. s. 2750, cross-section, left side; Azan; x 46. Anterior end of the bulla, showing relationship between ectotympanic, lateral bullar wall, and surrounding soft tissues.

b. s. 2740, cross-section, left side; Azan; x 90. Detail of ventral rim of the external acoustic meatus, showing nodules of cartilage-like material on its lip (asterisks).

a

b

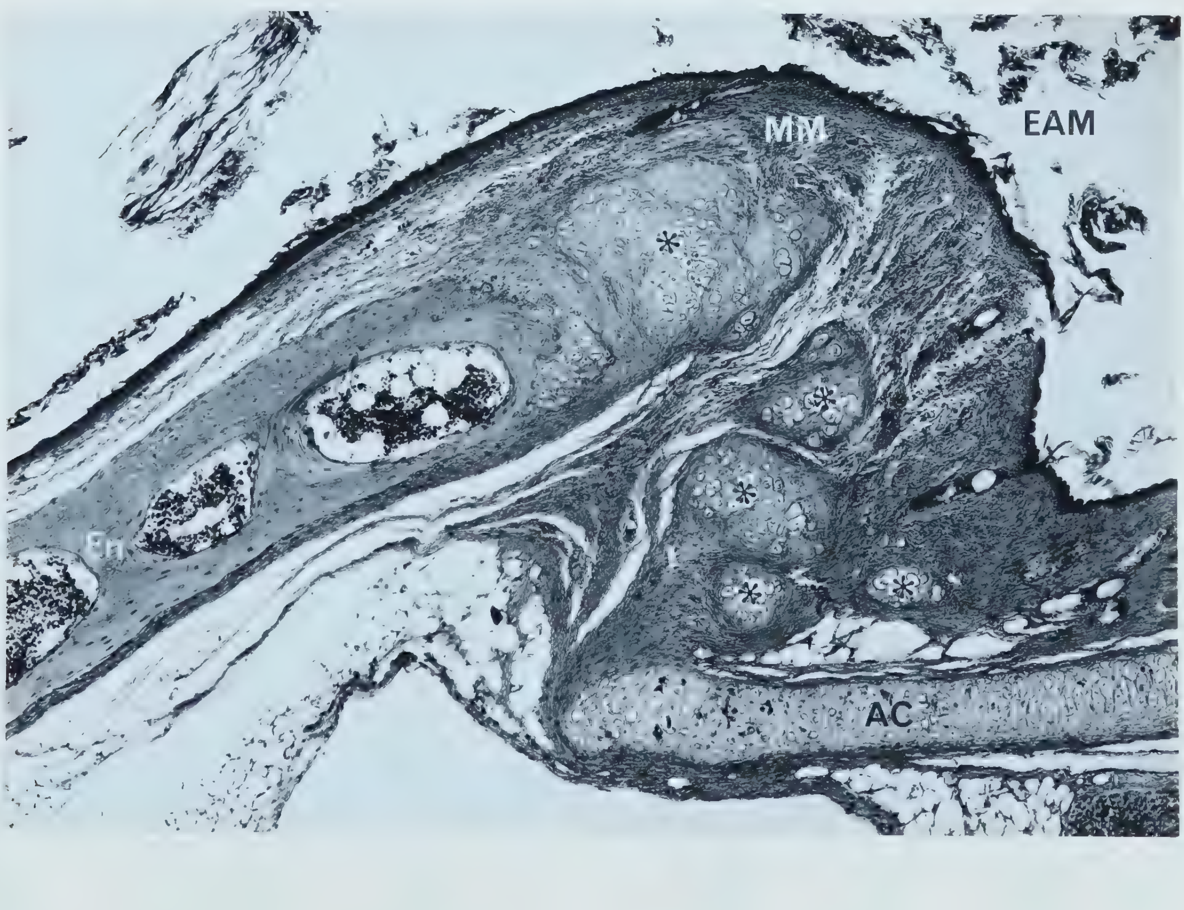


FIG. IV-40 *T. glis* MPIH 1961/11 (adult); s. 2920, cross-section, left side; Azan; x 19.

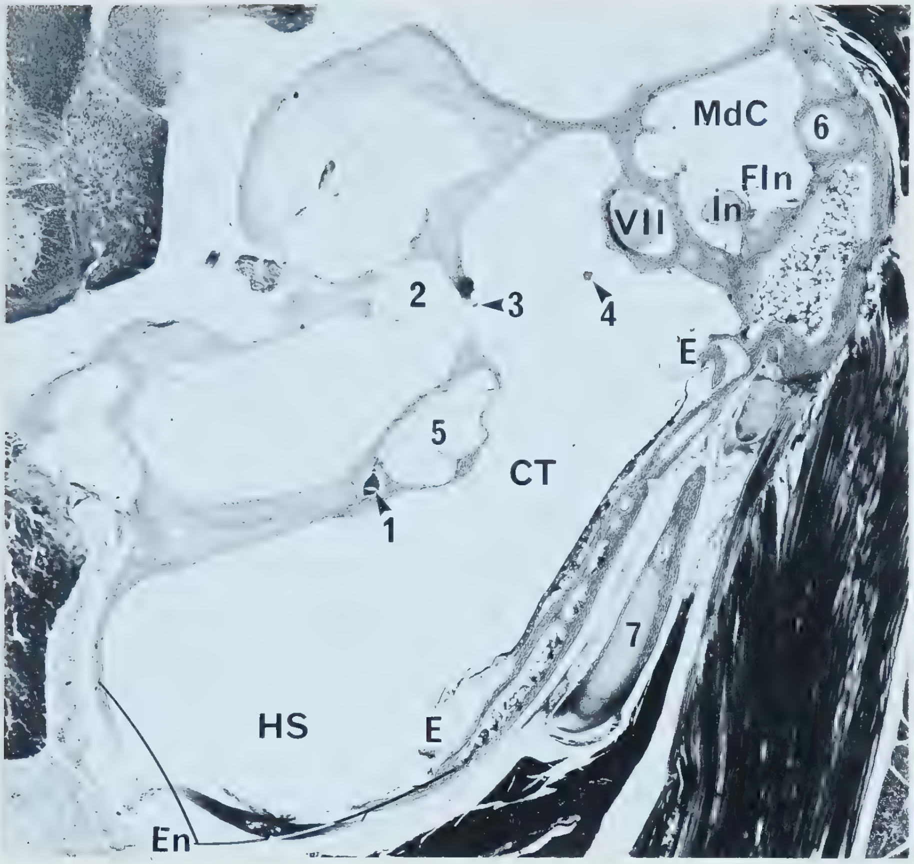
Posterior end of tympanic cavity, showing small mastoid cavity above fossa incudis. Note also the small size of the branches of the tympanic nerve compared to the internal carotid nerve.

1, internal carotid n.; 2, fossula fenestrae cochleae; 3, tympanic nerve (major branch); 4, tendon of stapedius m. in pyramidal canal; 5, carotid canal (artery disrupted during processing); 6, lateral semicircular canal.

FIG. IV-41 *T. glis* MPIH 1961/11 (adult); s. 2940, cross-section, left side; Azan; x 33.

Posterior end of tympanic cavity, showing end of small mastoid cavity. The tympano-styloid cartilage is an unossified remnant of Reichert's cartilage.

1, internal carotid n.; 2, tympanic n. (communicating branch); 3, tympanic n. (major branch); 4, stapedius m. in pyramidal canal; 5, carotid canal; 6, lateral semicircular canal; 7, tympano-styloid cartilage; 8, secondary tympanic membrane.


MdC
6
FIn
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VII
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E
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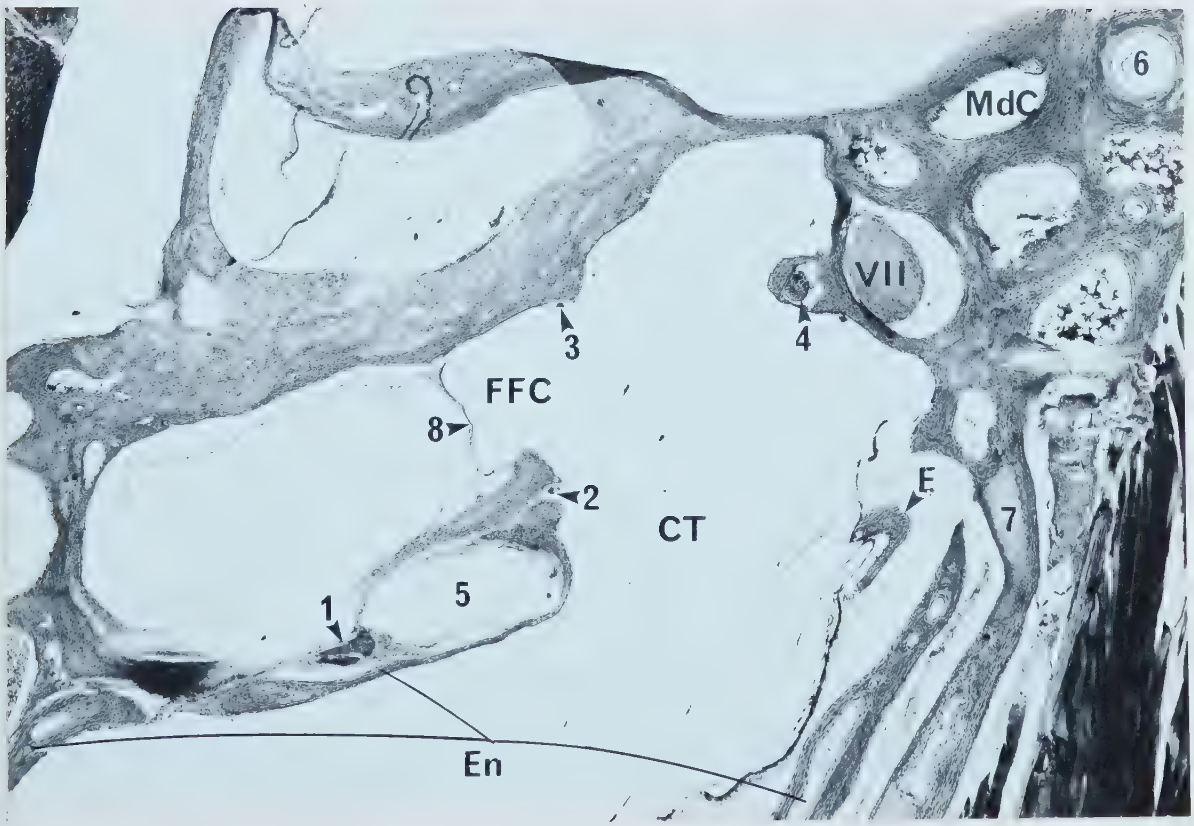
CT
1
7
HS
E
En


6
MdC
VII
3
4
FFC
8
2
CT
E
7
5
1
En

635

FIG. IV-42 *Ptilocercus lowii* USNM 112611 (adult); right auditory region, lateral aspect.

Note the large tympanic process of the alisphenoid, which is not found in Tupaiinae.

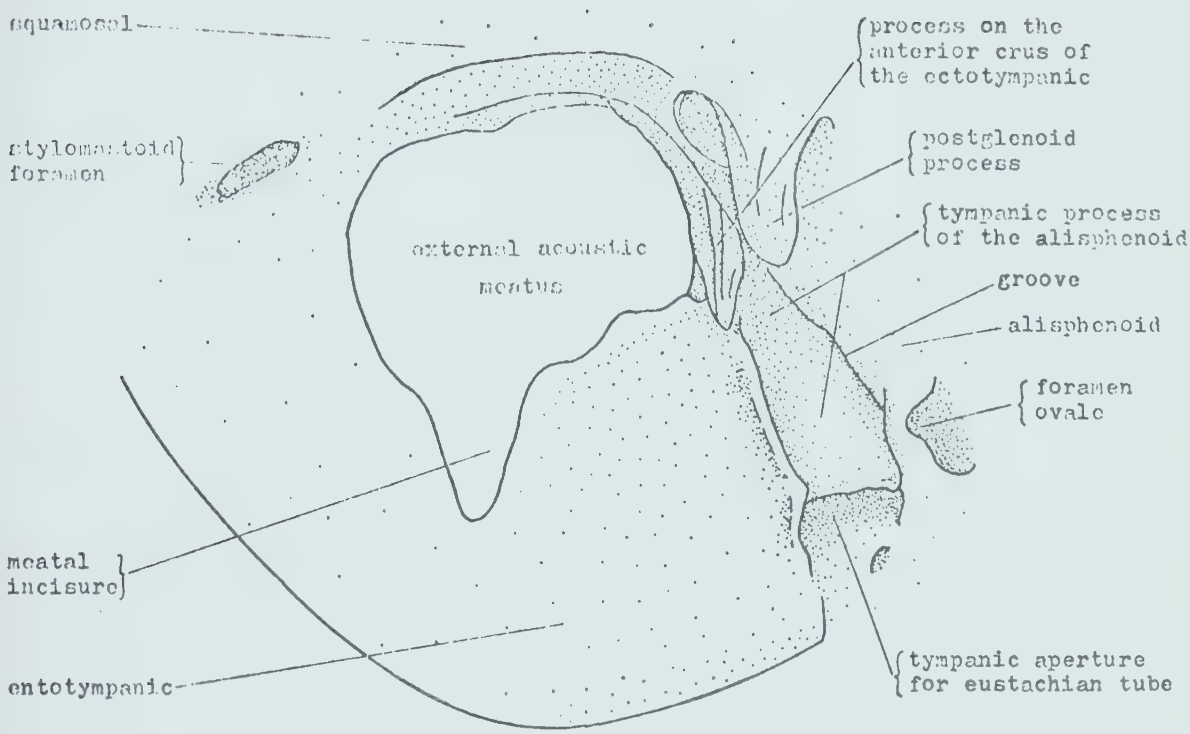

squamosal
stylomastoid foramen
external acoustic meatus
meatal incisure
entotympanic
process on the anterior crus of the ectotympanic
postglenoid process
tympanic process of the alisphenoid
groove
alisphenoid
foramen ovale
tympanic aperture for eustachian tube

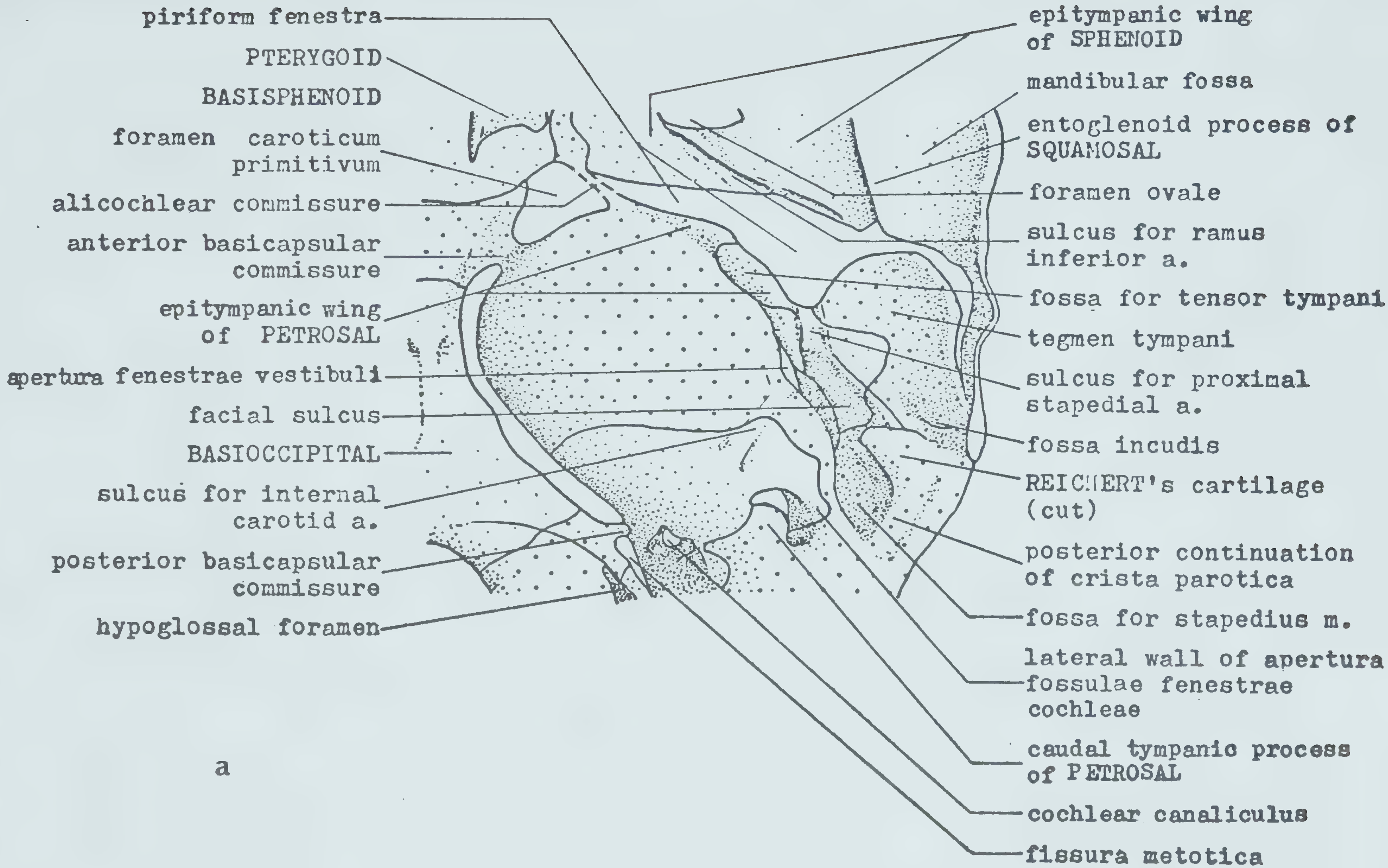
FIG. V-1 _E. fuscipes_ MPIH 311/E1 (fetus). Reconstruction of left auditory region and associated structures, ca. x 20. See fig. II-1 for shading conventions.

a. General anatomy.

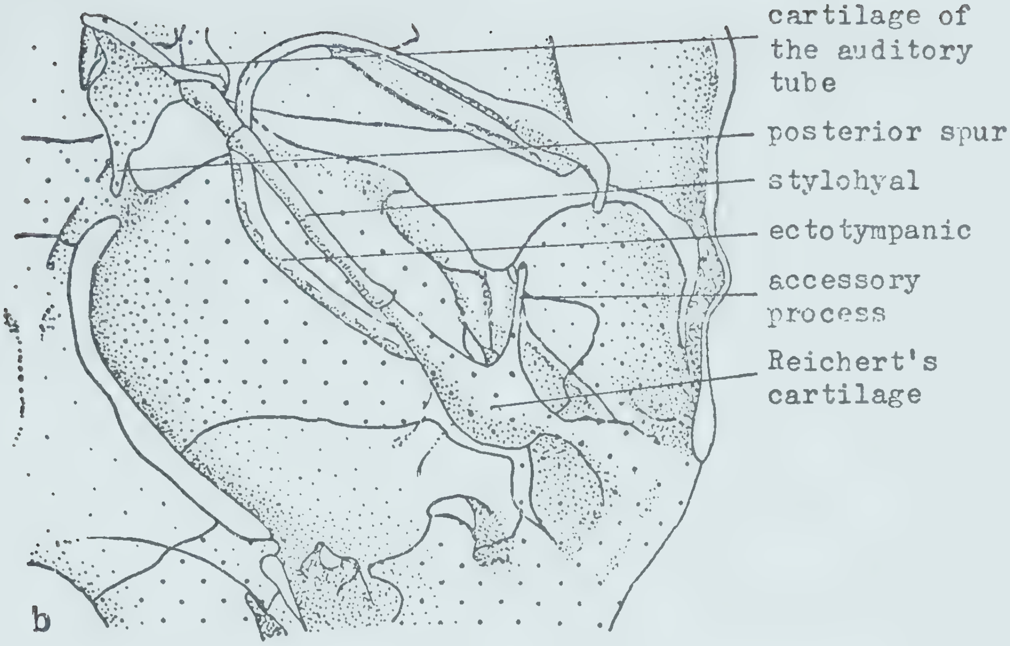
b. Ectotympanic, Reichert's cartilage and cartilage of the auditory tube _in situ_.

c. Routes of arteries and nerves.

The entotympanics and the rostral tympanic process of the petrosal are absent at this stage of development. The caudal tympanic process of the petrosal is represented only by its medial section, and the entoglenoid process of the squamosal is barely indicated. Other bullar components cannot be distinguished.

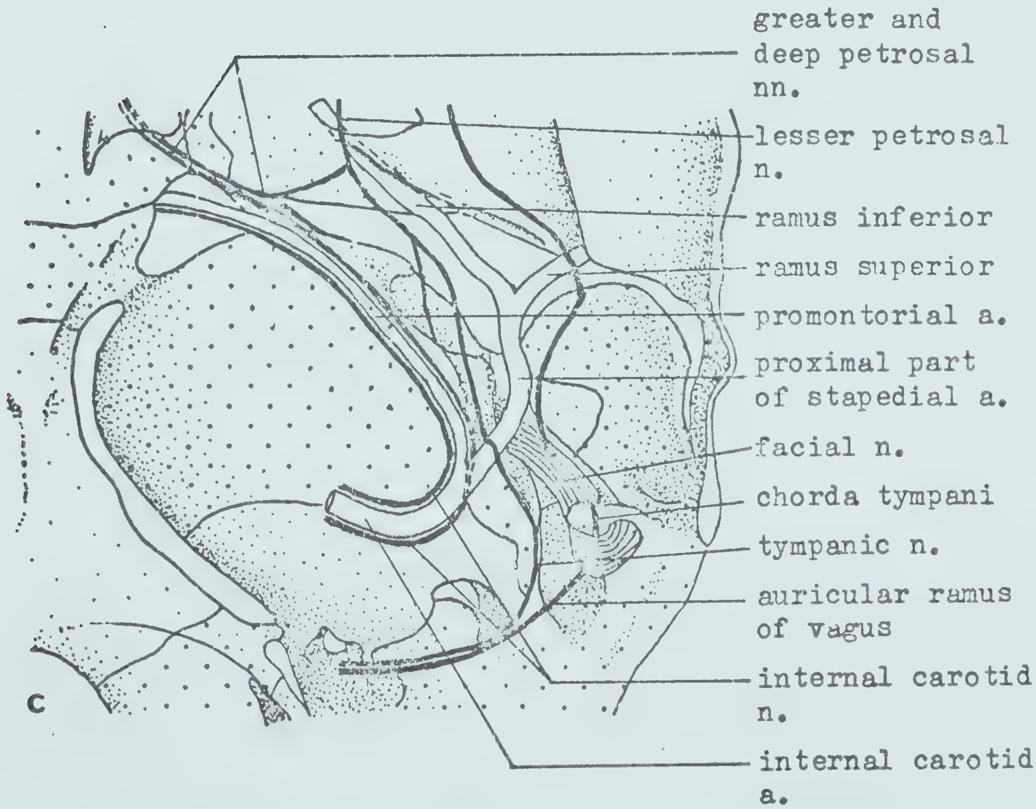

piriform fenestra
PTERYGOID
BASISPHENOID
foramen caroticum primitivum
alicochlear commissure
anterior basicapsular commissure
epitympanic wing of PETROSAL
apertura fenestrae vestibuli
facial sulcus
BASIOCCIPITAL
sulcus for internal carotid a.
posterior basicapsular commissure
hypoglossal foramen
epitympanic wing of SPHENOID
mandibular fossa
entoglenoid process of SQUAMOSAL
foramen ovale
sulcus for ramus inferior a.
fossa for tensor tympani
tegmen tympani
sulcus for proximal stapedial a.
fossa incudis
REICHERT's cartilage (cut)
posterior continuation of crista parotica
fossa for stapedius m.
lateral wall of apertura fossulae fenestrae cochleae
caudal tympanic process of PETROSAL
cochlear canaliculus
fissura metotica

a



cartilage of the auditory tube
posterior spur
stylohyal
ectotympanic
accessory process
Reichert's cartilage

b



greater and deep petrosal nn.
lesser petrosal n.
ramus inferior
ramus superior
promontorial a.
proximal part of stapedial a.
facial n.
chorda tympani
tympanic n.
auricular ramus of vagus
internal carotid n.
internal carotid a.

c

FIG. V-2 *E. rozeti* adult. General view of left auditory region; depicted from the posteroventral aspect, in order to expose the position of the tympanic end of the pterygoid canal.

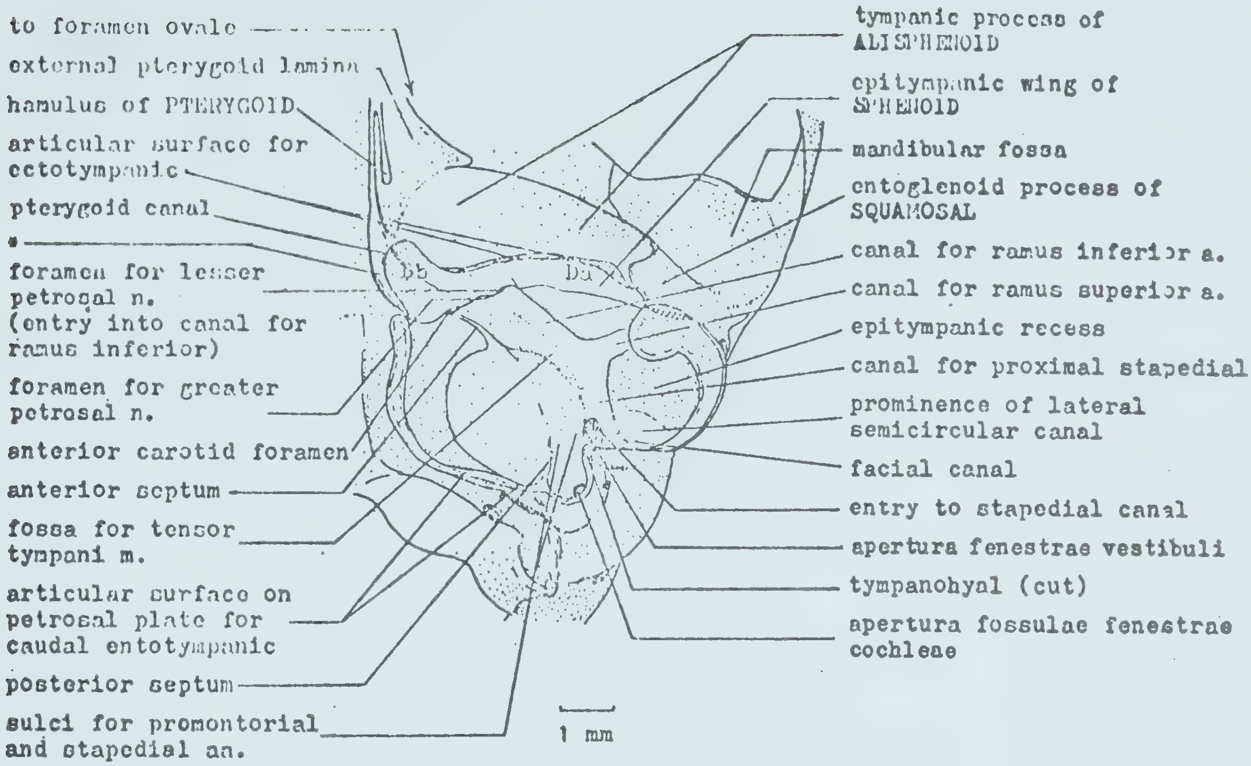
The caudal entotympanic and most of the ectotympanic have been removed (cf. fig. V-3). Designations of diverticula (Da, Db) are those of SABAN (1956-57). Diverticulum D_3 is very small and is covered by the section of the petrosal plate derived from the caudal tympanic process of the petrosal; it is not visible in this illustration. It lies behind the apertura fossulae fenestrae cochleae, as usual.

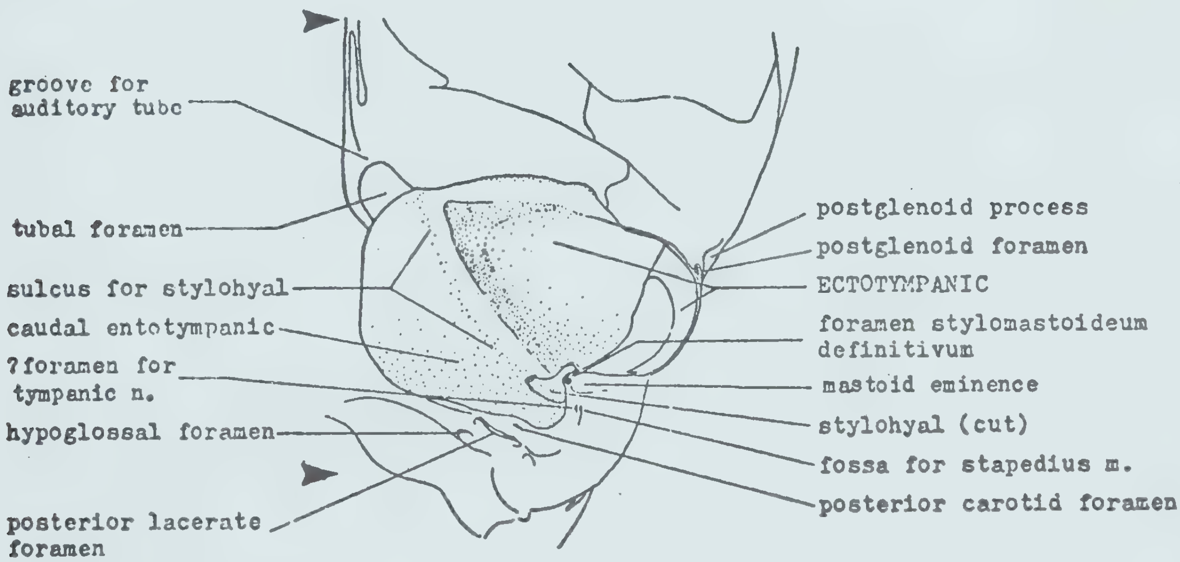
*, tympanic process of the basisphenoid.

FIG. V-3 *E. rozeti* adult. This illustration is identical to fig. V-2 except that here the fused caudal entotympanic-ectotympanic is shown *in situ*.

The boundary between the elements originally lay along or near the shallow sulcus for the stylohyal (most of which has been cut away).

FIG. V-4 *E. rozeti* adult. Medial wall of the bulla as seen from the mid-sagittal plane. The area included in this figure is indicated by the arrows in fig. V-3.


to foramen ovale
external pterygoid lamina
hamulus of PTERYGOID
articular surface for ectotympanic
pterygoid canal
*
foramen for lesser petrosal n. (entry into canal for ramus inferior)
foramen for greater petrosal n.
anterior carotid foramen
anterior septum
fossa for tensor tympani m.
articular surface on petrosal plate for caudal entotympanic
posterior septum
sulci for promontorial and stapedial aa.
1 mm
tympanic process of ALISPHENOID
epitympanic wing of SPHENOID
mandibular fossa
entoglenoid process of SQUAMOSAL
canal for ramus inferior a.
canal for ramus superior a.
epitympanic recess
canal for proximal stapedial
prominence of lateral semicircular canal
facial canal
entry to stapedial canal
apertura fenestrae vestibuli
tympanohyal (cut)
apertura fossulae fenestrae cochleae


groove for auditory tube
tubal foramen
sulcus for stylohyal
caudal entotympanic
?foramen for tympanic n.
hypoglossal foramen
posterior lacerate foramen
postglenoid process
postglenoid foramen
ECTOTYMPANIC
foramen stylomastoideum definitivum
mastoid eminence
stylohyal (cut)
fossa for stapedius m.
posterior carotid foramen

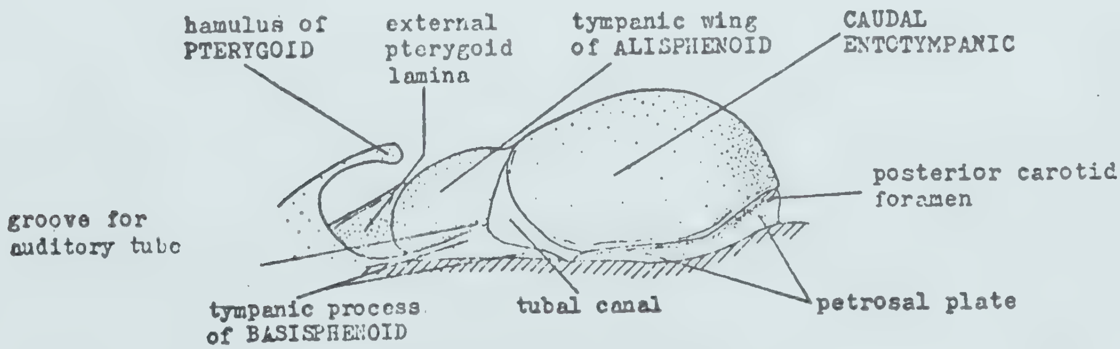

hamulus of PTERYGOID
external pterygoid lamina
tympanic wing of ALISPHENOID
CAUDAL ENTOTYMPANIC
posterior carotid foramen
groove for auditory tube
tympanic process of BASISPHENOID
tubal canal
petrosal plate

FIG. V-5 Development of the bulla in macroscelidean fetuses (adapted from VAN DER KLAAUW 1929). Semidiagrammatic ventral views; only the components of the bulla have been reconstructed.

I - Rhynchocyon sp.; II - Macroscelides ?rozeti; III - Macroscelides sp.; IV - Petrodromus sultani; V - Rhynchocyon sp.; VI - Petrodromus sultani; VII - Macroscelides brachyrynchus.

In the catalogue of the Hubrecht Laboratory (BOTERENBROOD 1977), specimen II is now listed as Elephantulus rozeti and specimen VII as Elephantulus brachyrhynchus. In order to avoid confusion, the taxon names used by VAN DER KLAAUW (1929) are used in the text.

a.c., accessory cartilage; a.m.c.t. anterior margin of cartilage of auditory tube; c.e., caudal entotympanic; c.t., cartilage of auditory tube; e., ectotympanic; e.p.s., entoglenoid process of squamosal; p.t.b., tympanic process of the basisphenoid (may include pterygoidal material as well); p.t.p.c., caudal tympanic process of petrosal; p.t.p.r., rostral tympanic process of petrosal; t.p.a., tympanic process of alisphenoid; r.e., rostral entotympanic.

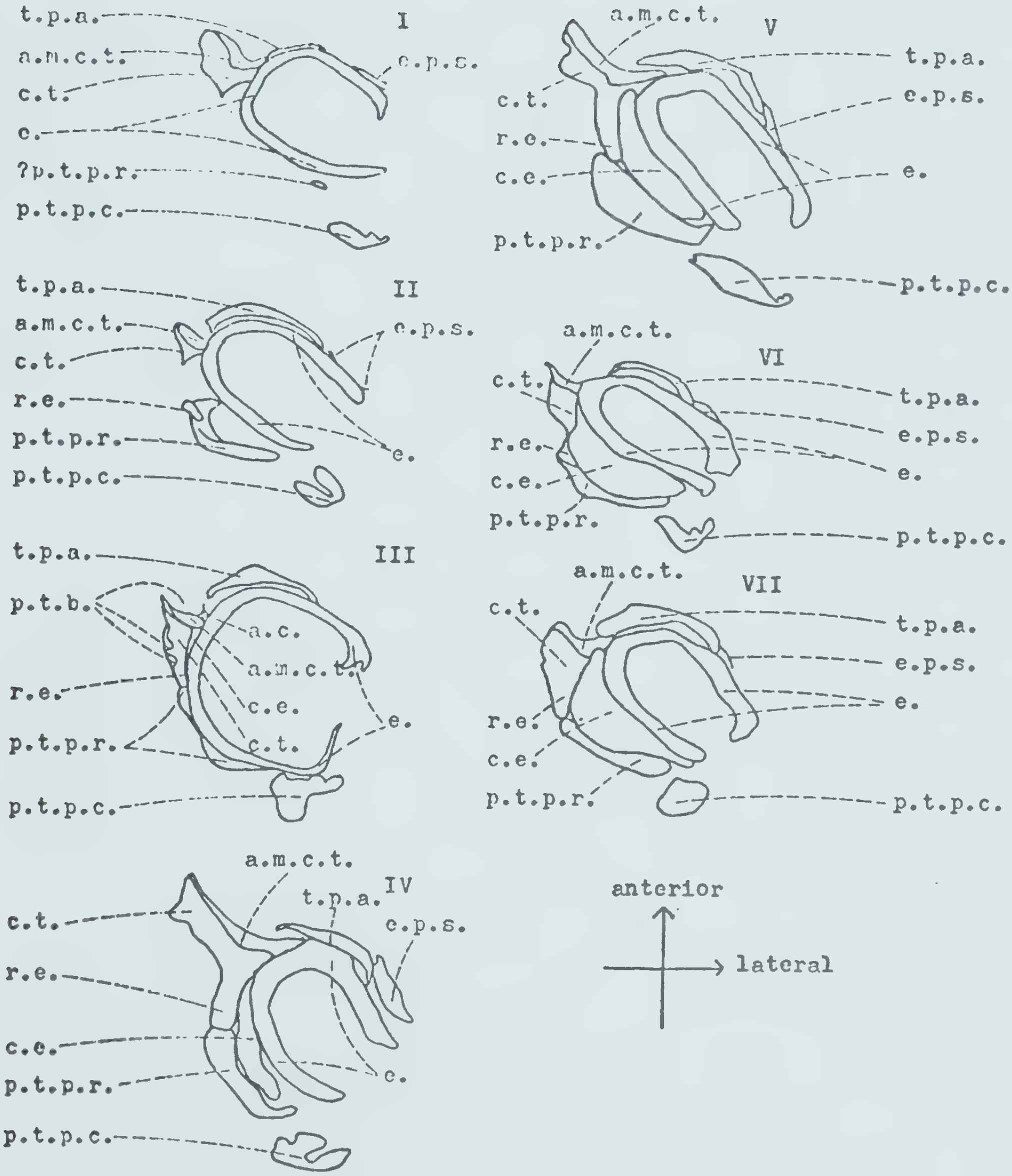

I
t.p.a.
a.m.c.t.
c.t.
c.
?p.t.p.r.
p.t.p.c.
e.p.s.
II
t.p.a.
a.m.c.t.
c.t.
r.e.
p.t.p.r.
p.t.p.c.
e.p.s.
e.
III
t.p.a.
p.t.b.
r.e.
p.t.p.r.
p.t.p.c.
a.c.
a.m.c.t.
c.e.
c.t.
e.
IV
a.m.c.t.
t.p.a.
c.t.
r.e.
c.e.
p.t.p.r.
p.t.p.c.
e.p.s.
e.
V
a.m.c.t.
c.t.
r.e.
c.e.
p.t.p.r.
t.p.a.
e.p.s.
e.
p.t.p.c.
VI
a.m.c.t.
c.t.
r.e.
c.e.
p.t.p.r.
t.p.a.
e.p.s.
e.
p.t.p.c.
VII
a.m.c.t.
c.t.
r.e.
c.e.
p.t.p.r.
t.p.a.
e.p.s.
e.
p.t.p.c.
anterior
lateral

FIG. V-6 E. fuscipes MPIH 311/E1 (fetus); s. 1100, cross-section, right side (sides rev.); Azan; x 44.

Anterior (pharyngeal) section of the cartilage of the auditory tube. The nerves of the pterygoid canal pass between the sphenoid and the posterior end of the pterygoid (which is still free at this stage of development). The ramus inferior issues into the temporal fossa adjacent to foramen ovale.

For key to numbered structures, see fig. V-7.

FIG. V-7 E. fuscipes MPIH 311/E1 (fetus); s. 1120, cross-section, right side (sides rev.); Azan; x 44.

The tympanic process of the alisphenoid partly arises from the ridge (6) which borders the sulcus for the ramus inferior a., although this is not particularly evident at this stage.

1, ramus inferior of the stapedial a.; 2, lesser petrosal n.; 3, nerves of the pterygoid canal; 4, chorda tympani; 5, gonial; 6, ridge on sulcus for ramus inferior a.; 7, ala temporalis.

BS
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Ph
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MC
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CH
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Sq
BS
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CAT
3
2
Pt
Ma
4
MC
E
Ph
CT
5
E
RC
CH

FIG. V-8 *E. fuscipes* MPIH 311/E1 (fetus); s. 1130, cross-section, right side (sides rev.); Azan; x 44.

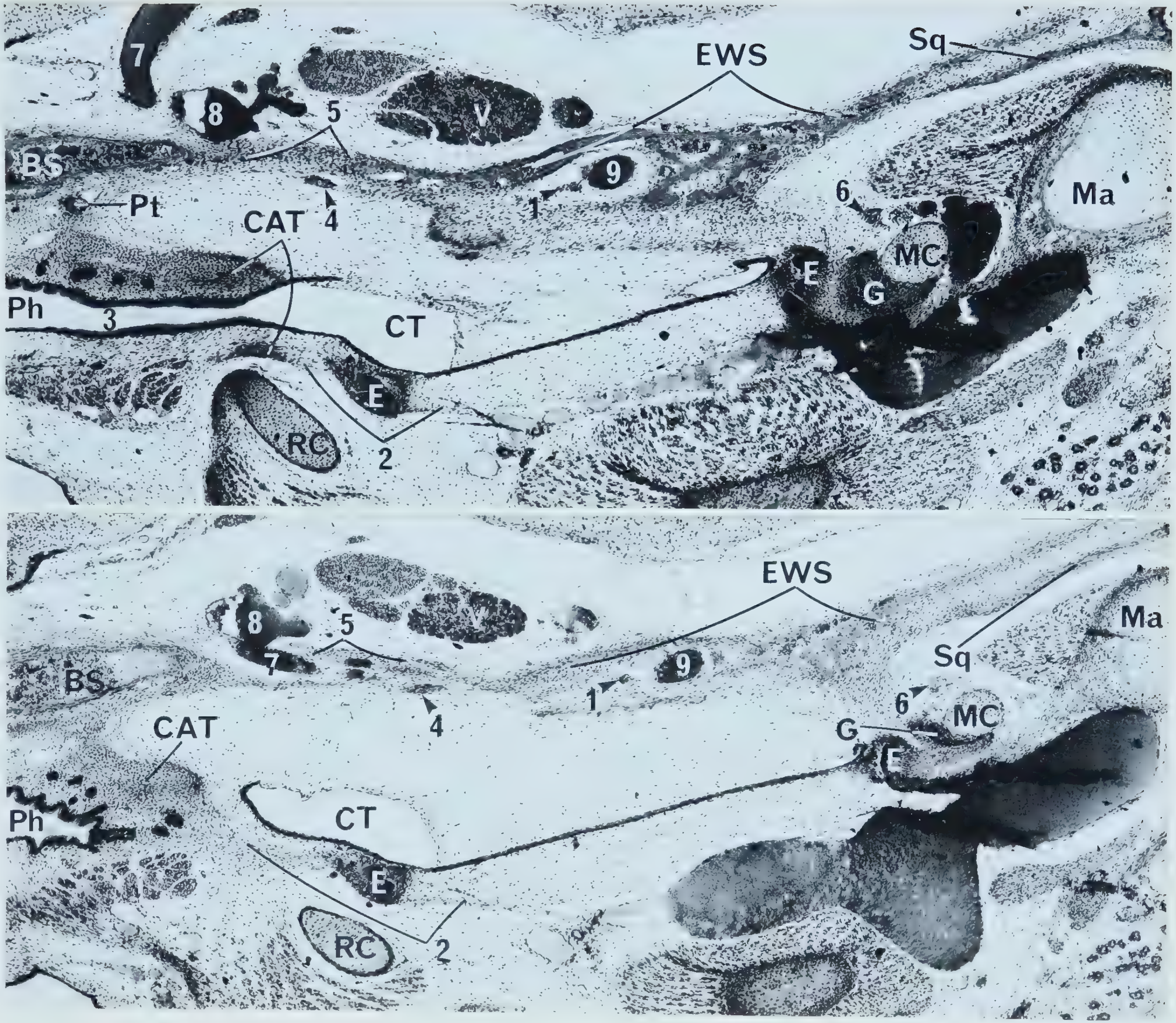
Section through pharyngeal and tympanic apertures of the auditory tube. The reflected anterior margin of the cartilage of the auditory tube ends at this point, but the dorsal part of the cartilage extends further posteriorly.

1, lesser petrosal n.; 2, FMTC; 3, lumen of auditory tube; 4, nerves of pterygoid canal; 5, alicochlear commissure (degenerating); 6, chorda tympani; 7, promontorial a. passing through foramen caroticum primitivum; 8, cavernous sinus; 9, ramüs inferior of stapedial a.

FIG. V-9 *E. fuscipes* MPIH 311/E1 (fetus); s. 1150, cross-section, right side (sides rev.); Azan; x 44.

Section through foramen caroticum primitivum. The alicochlear commissure is degenerating. The fibrous membrane is poorly defined anteriorly.

For key to numbered structures, see fig. V-8.



Sq
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BS
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CT
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RC
2
EWS
8
5
V
9
Ma
Sq
7
BS
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4
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MC
CAT
G
E
Ph
CT
E
RC
2

648

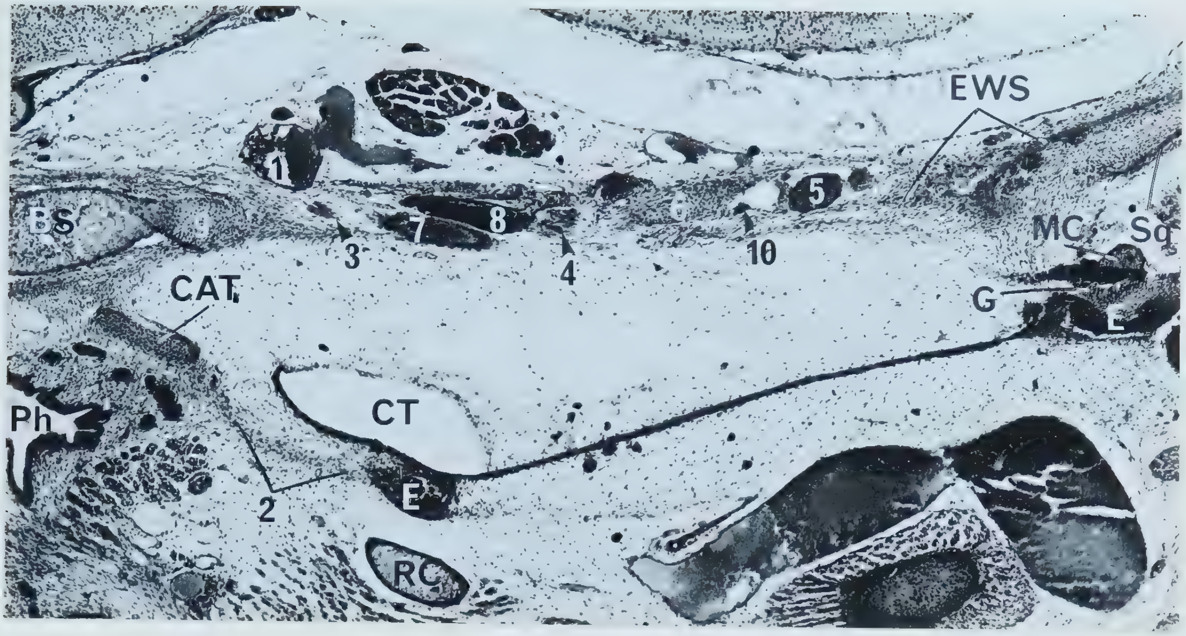
FIG. V-10 *E. fuscipes* MPIH 311/E1 (fetus); s. 1160, cross-section, right side (sides rev.); Azan; x 44.

Posterior part of the cartilage of the auditory tube, embedded in fibrous membrane of tympanic cavity. Stylohyal center visible in Reichert's cartilage.

1, cavernous sinus; 2, FMTC; 3, part of internal carotid n.; 4, meeting of deep petrosal n. (from internal carotid n.) and greater petrosal n; 5, ramus inferior of stapedial a.; 6, alicochlear commissure; 7, promontorial a.; 8, vein (to cavernous plexus); 9, anterior basicapsular commissure ; 10, lesser petrosal n.

FIG. V-11 *E. fuscipes* MPIH 311/E1 (fetus); s. 1190, cross-section, right side (sides rev.); Azan; x 117.

Section through posterior spur of the cartilage of the auditory tube. Anlage of caudal entotympanic not evident within fibrous membrane of the tympanic cavity at this stage of development.


EWS
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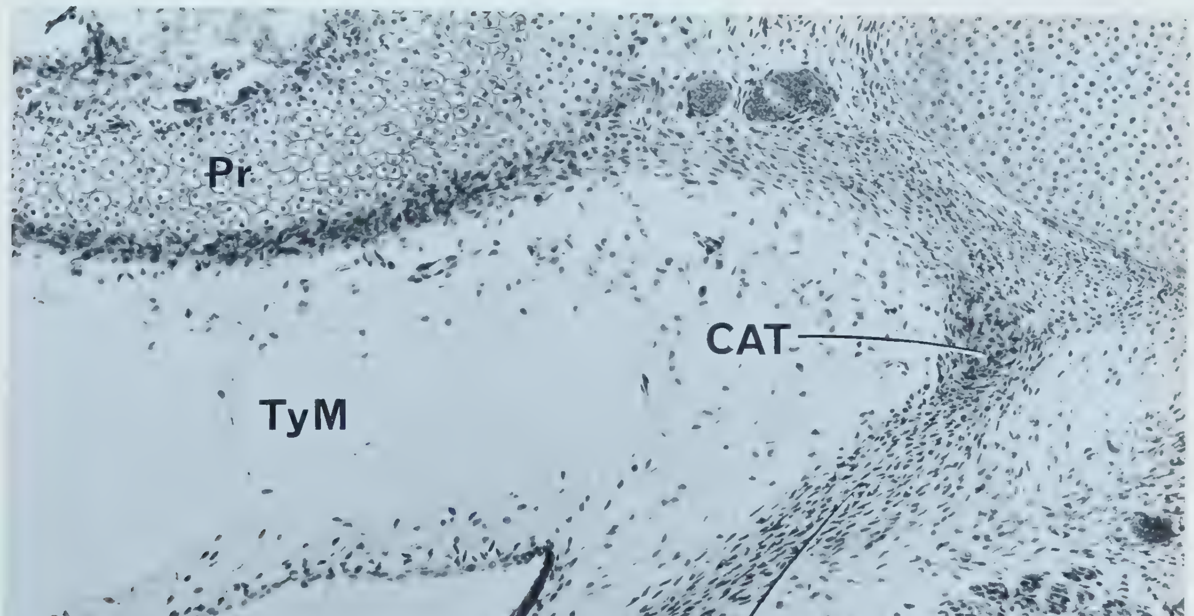
BS
3
7
8
4
6
5
10
MC
Sq
CAT
G
L
Ph
CT
2
E
RC


Pr
CAT
TyM
CT
FMTC
E

650

FIG. V-12 _E. fuscipes_ MPIH 311/E1 (fetus); s. 1290, cross-section right side (sides rev.); Azan; x 86.

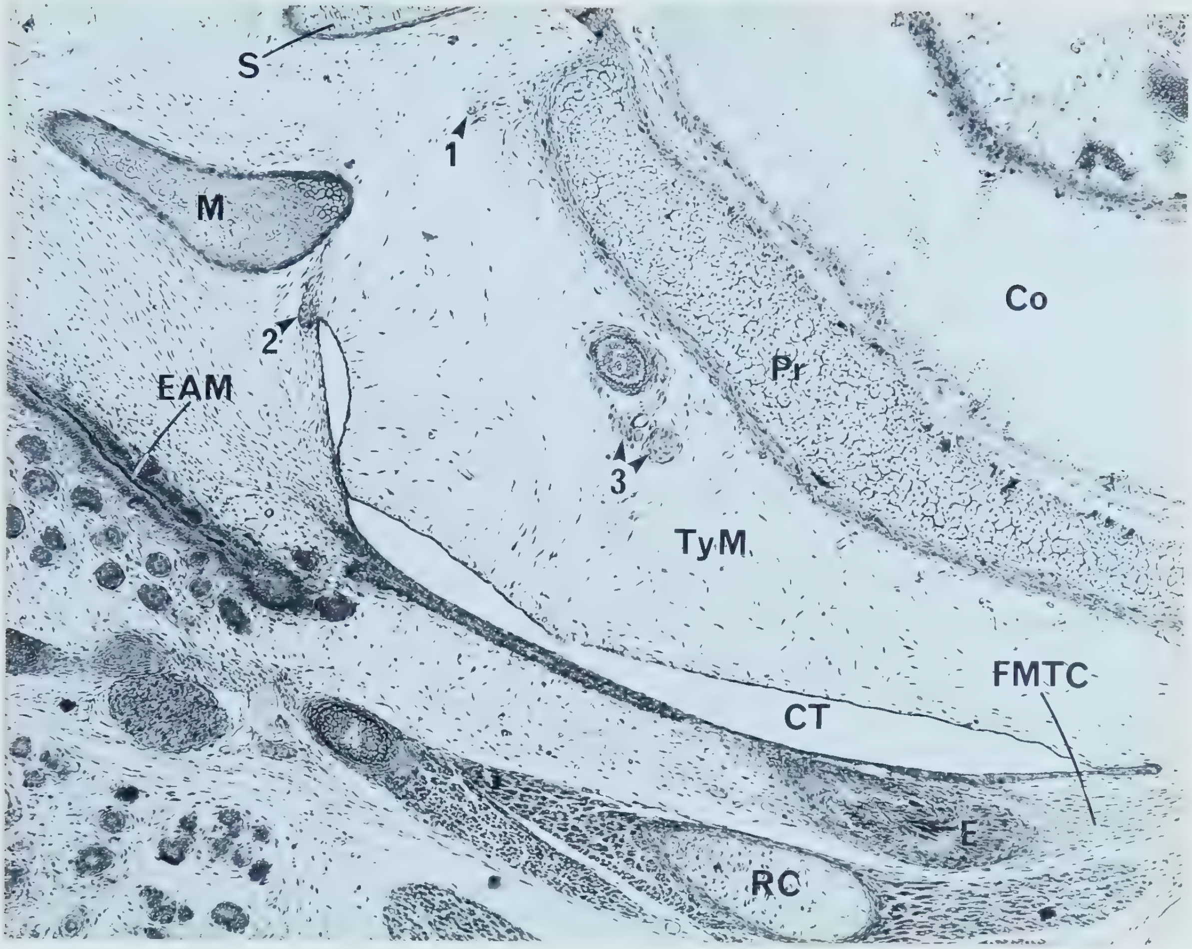
Accessory process of Reichert's cartilage. This process is not closely associated with the chorda tympani and is therefore unlikely to be an element of Spence.

1, tympanic n.; 2, chorda tympani; 3, divisions of internal carotid n.; 4, accessory process of Reichert's cartilage; 5, promontorial a.

FIG. V-13 _E. fuscipes_ MPIH 311/E1 (fetus); s. 1370, cross-section, left side; Azan; x 44.

Section through (membranous) posterior carotid foramen.

1, internal carotid a.; 2, internal carotid n.; 3, local thickening of fibrous membrane of tympanic cavity; 4, tympanic n.


S
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M
Co
2
Pr
EAM
3
TyM
FMTC
CT
E
RC

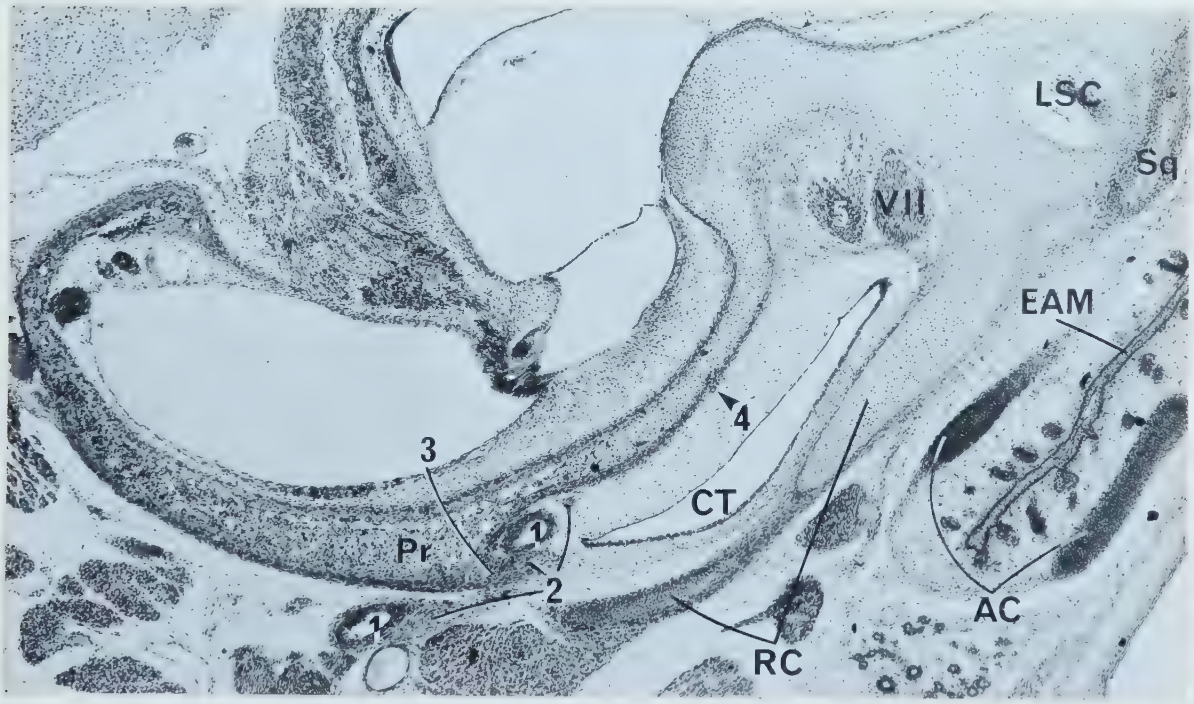

LSC
Sq
VII
EAM
4
3
CT
1
Pr
2
1
AC
RC

FIG. V-14 E. fuscipes MPIH 311/E1 (fetus).

a. s. 1411, cross-section, right side (sides rev.); Cresyl Violet; x 44.

b. s. 1430, cross-section, left side; Azan; x 44.

c. s. 1431, cross-section, right side (sides rev.); Cresyl Violet; x 44.

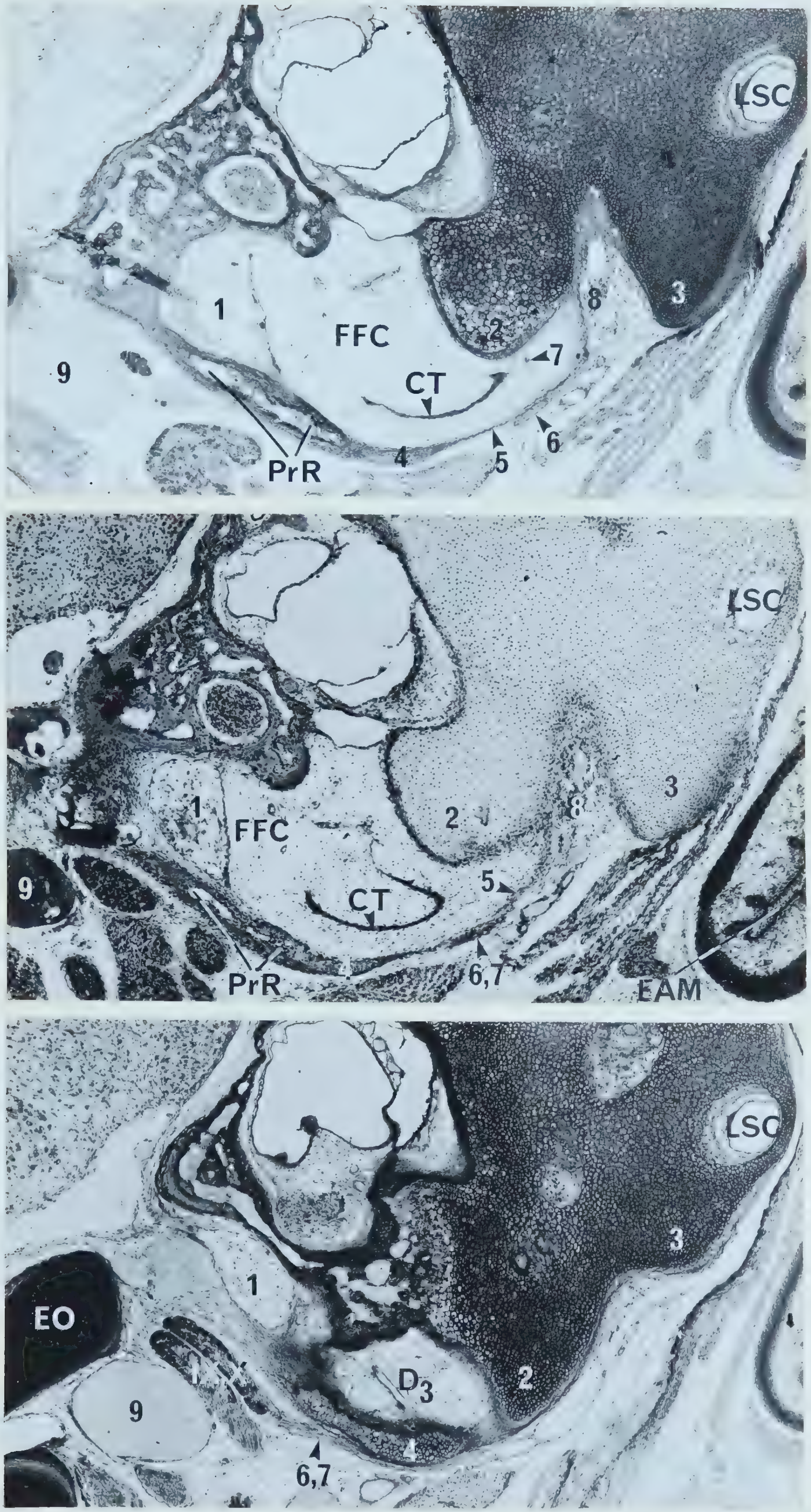
Series of cross-sections through the posterior part of the tympanic cavity. The medial section of the caudal tympanic process of the petrosal is a lateral prolongation of the processus recessus beneath the apertura fossulae fenestrae cochleae and diverticulum D_3. The massive lateral wall of the apertura forms the medial wall of the fossa for the stapedius muscle. Adult conditions (fig. V-2) indicate that the lateral wall of the apertura eventually forms the rest of the caudal tympanic process of the petrosal, thus enclosing a diverticulum D_3 of very small dimensions. Note that the fibrous membrane of the tympanic cavity attaches to the lateral wall of the apertura, not to the posterior continuation of the crista parotica. As a result, the origin of the stapedius muscle is excluded from the presumptive tympanic cavity.

1, perilymphatic duct; 2, lateral wall of fossula fenestrae cochleae; 3, posterior continuation of crista parotica; 4, caudal tympanic process of petrosal (medial section); 5, FMTC; 6, auricular ramus of vagus; 7, tympanic n. (travelling with ramus auricularis); 8, stapedius m.; 9, internal jugular v.

a

b

c



654

FIG. V-15 *E. fuscipes* MPIH 305/E (fetus); s. 1421, cross-section, left side; Azan; x 44.

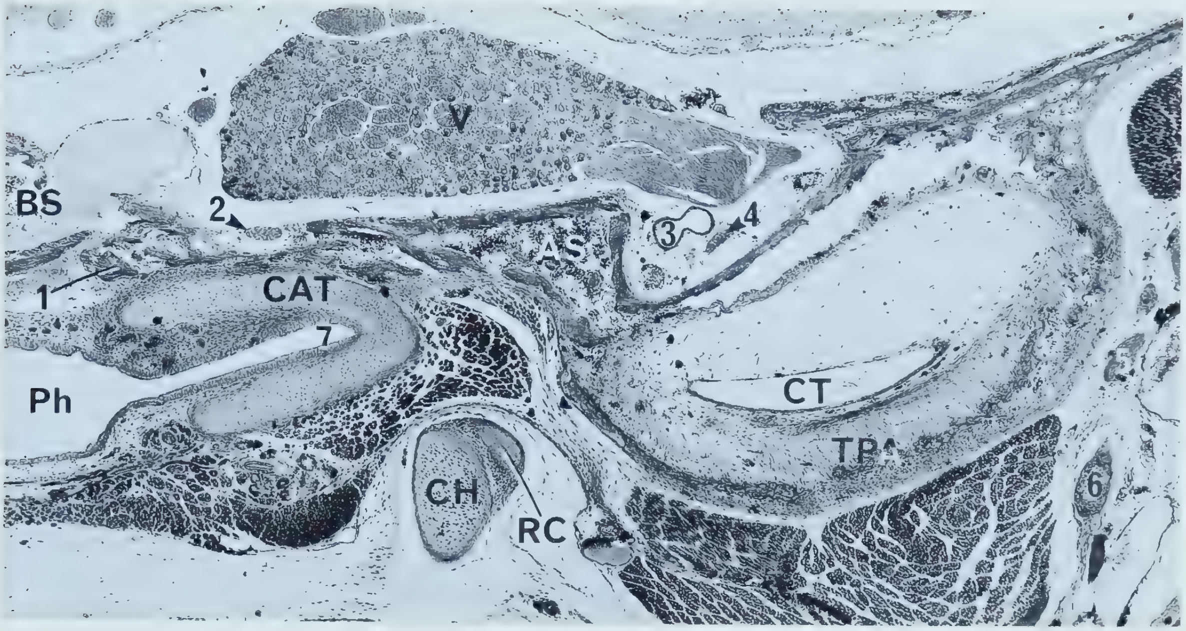
Anterior (pharyngeal) part of the cartilage of the tube and the tympanic process of the alisphenoid. The bone lying beneath the nerves of the pterygoid canal is probably derived from the posterior part of the pterygoid (which is now fused to the sphenoid). Note the small ridge (1) above the pharyngeal aperture of the auditory tube.

1, ridge (rudiment of tympanic process of basisphenoid); 2, nerves of pterygoid canal; 3, ramus inferior of stapedial a.; 4, lesser petrosal n.; 5, chorda tympani; 6, Meckel's cartilage (degenerating); 7, lumen of auditory tube.

FIG. V-16 *E. fuscipes* MPIH 305/E (fetus); s. 1431, cross-section, left side; Azan; x 44.

Anterior (pharyngeal) part of the cartilage of the tube and the entoglenoid process of the squamosal. The entoglenoid is small at this stage and does not overlap the tympanic process of the alisphenoid.

For key to numbered structures, see fig. V-15.



V
BS
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3
4
AS
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CAT
7
Ph
CT
CH
RC
6

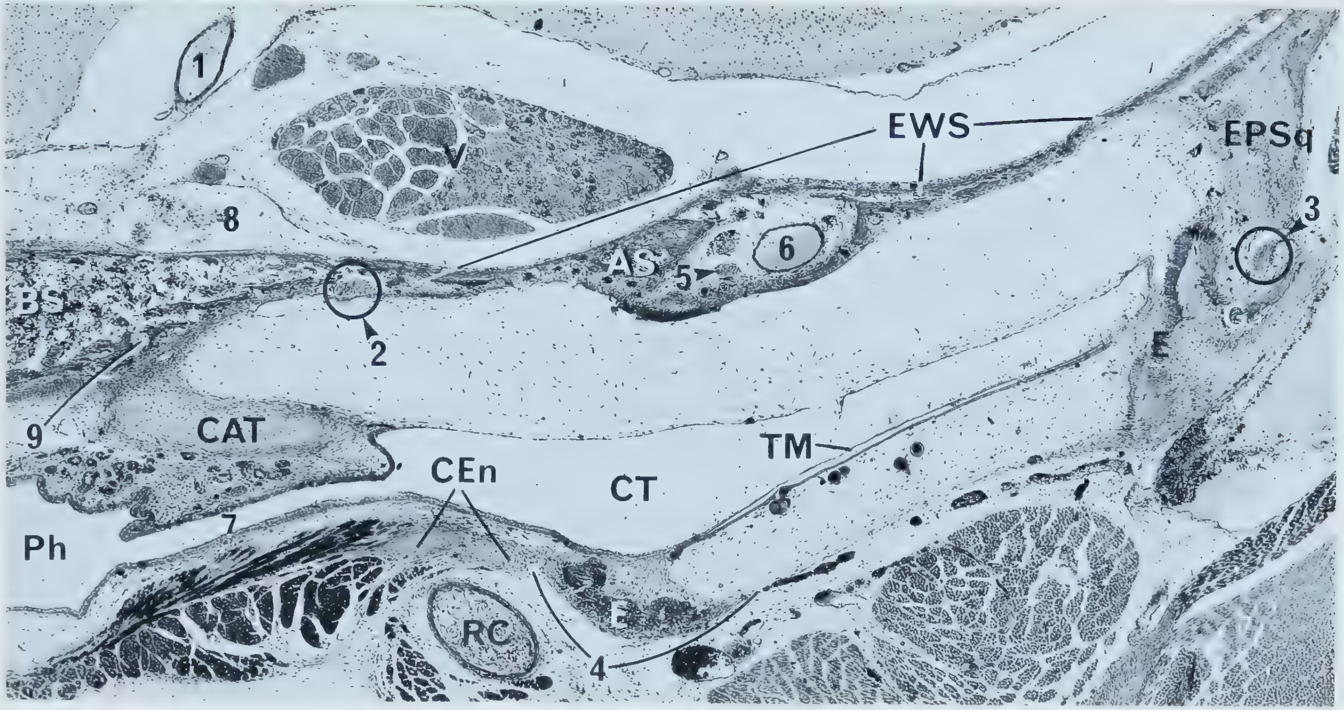
V
3
AS
4
1
CAT
Ph
CT
E
5
6
CH
RC

656

FIG. V-17 *E. fuscipes* MPIH 305/E (fetus); s. 1481, cross-section, left side; Azan; x 44.

Relationship of the anterior end of the caudal entotympanic and the tubal cartilage.

1, promontorial a. (cerebral carotid a.); 2, nerves of pterygoid canal; 3, chorda tympani; 4, FMTC; 5, lesser petrosal n.; 6, ramus inferior of stapedial a.; 7, lumen of auditory tube; 8, cavernous sinus; 9, ridge (rudiment of tympanic process of basisphenoid).



1
EWS
EPSq
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BS
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E
9
CAT
TM
CEn
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7
Ph
RC
E
4

FIG. V-18 *E. fuscipes* MPIH 305/E (fetus); s. 1531, cross-section, left side; Azan; x 44.

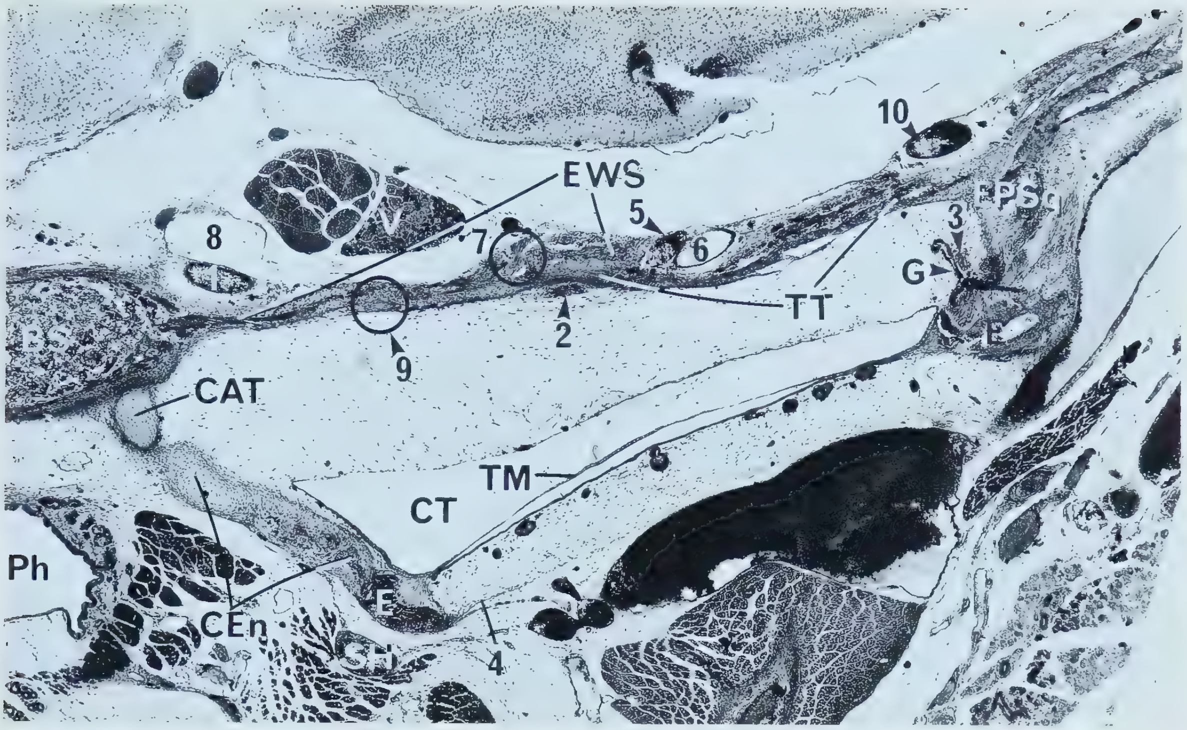
Relationship of the posterior spur of the tubal cartilage and the dorsal margin of the caudal entotympanic. As may be seen in fig. V-17 as well, the two elements are not fused.

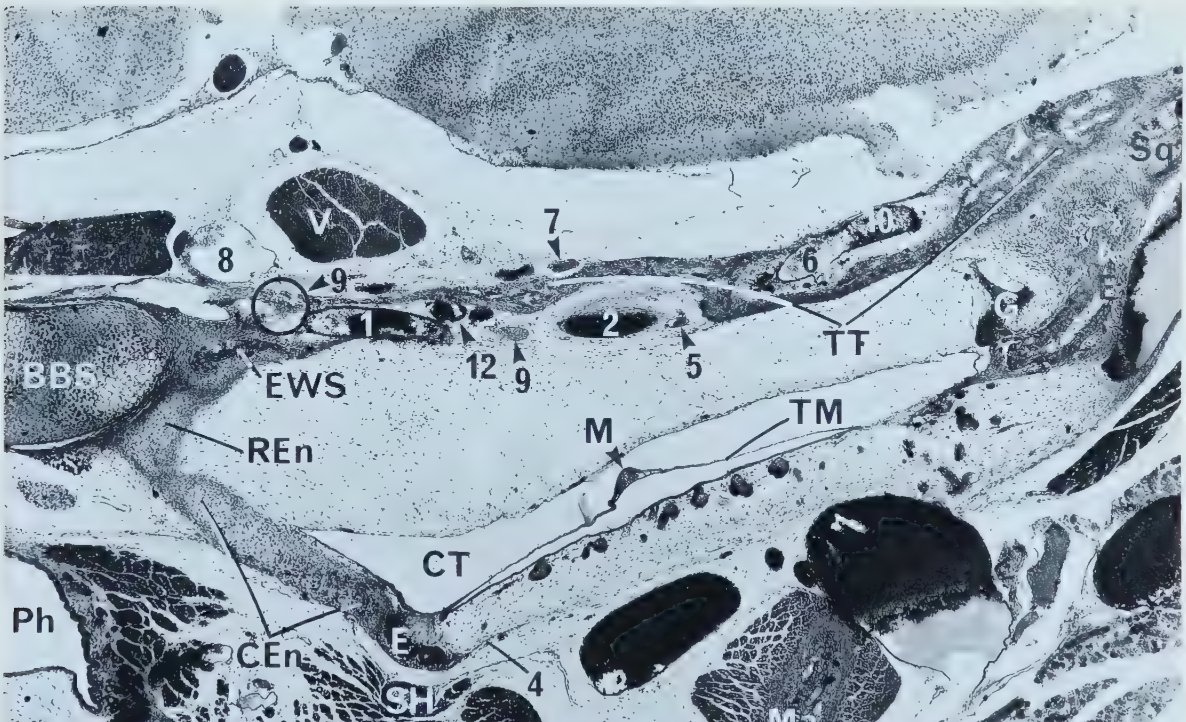
1, promontorial a. (cerebral carotid a.); 2, tensor tympani m.; 3, chorda tympani; 4, FMTC; 5, lesser petrosal n.; 6, ramus inferior of stapedial a.; 7, greater petrosal n.; 8, cavernous sinus; 9, deep petrosal n. (from internal carotid n.); 10, ramus superior of stapedial a.; 12, vein (to cavernous sinus).

FIG. V-19 *E. fuscipes* MPIH 305/E (fetus); s. 1558, cross-section; left side; Azan; x 31.

Anterior end of rostral entotympanic.

For key to numbered structures, see fig. V-18.


10
EWS
FPSq
V
8
7
5
6
3
G
TT
2
9
E
CAT
TM
CT
Ph
E
CEn
SH
4


Sq
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10
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TT
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2
12
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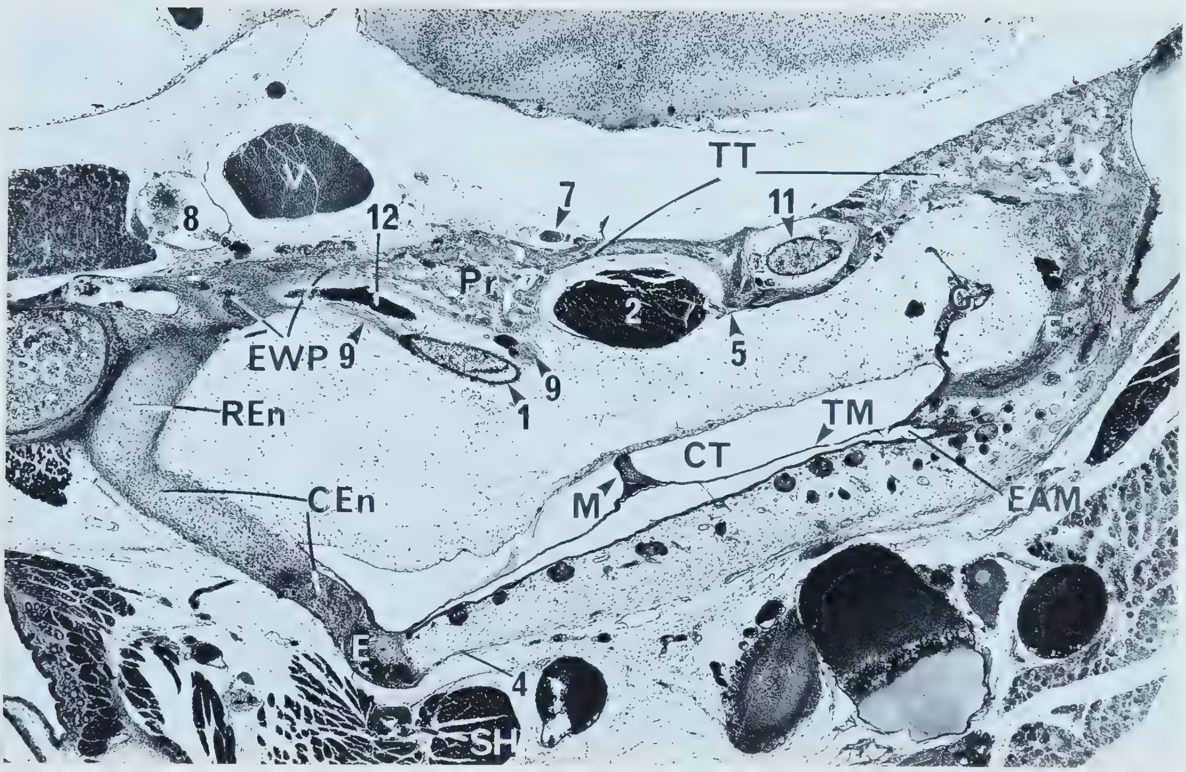
5
G
BBS
EWS
REn
TM
M
CT
Ph
CEn
E
SH
4
Ma

660

FIG. V-20 *E. fuscipes* MPIH 305/E (fetus); x. 1581, cross-section, left side; Azan; x 31.

Section through anterior pole of promontory.

For key to numbered structures, see fig. V-18.


TT
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11
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EWP
9
9
1
REn
TM
CT
M
CEn
EAM
E
4
SH

662

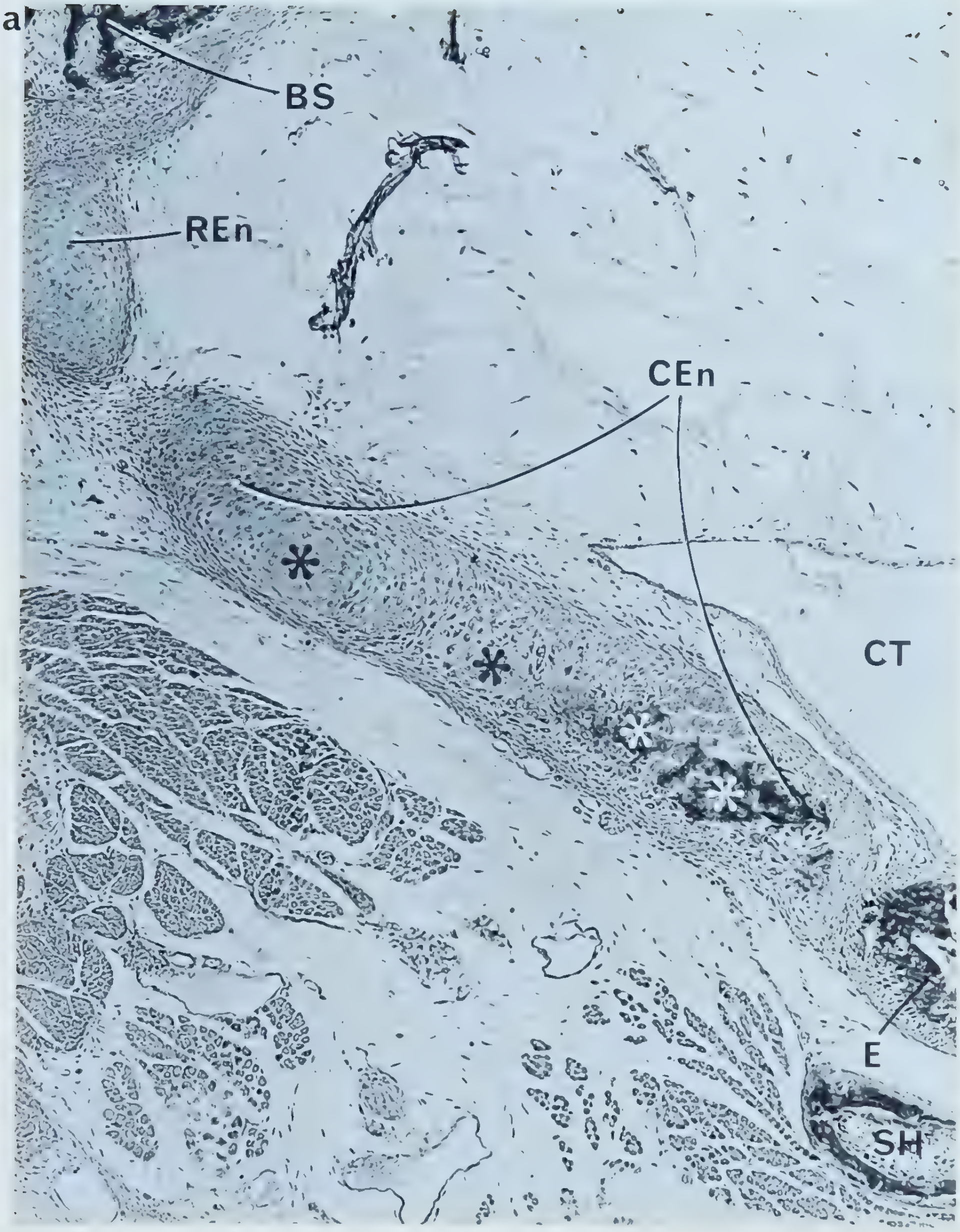
FIG. V-21 _E. fuscipes_ MPIH 305/E (fetus).

Visualization of the caudal entotympanic using different histological methods. Black asterisks indicate secondary cartilage and white asterisks indicate bone tissue.

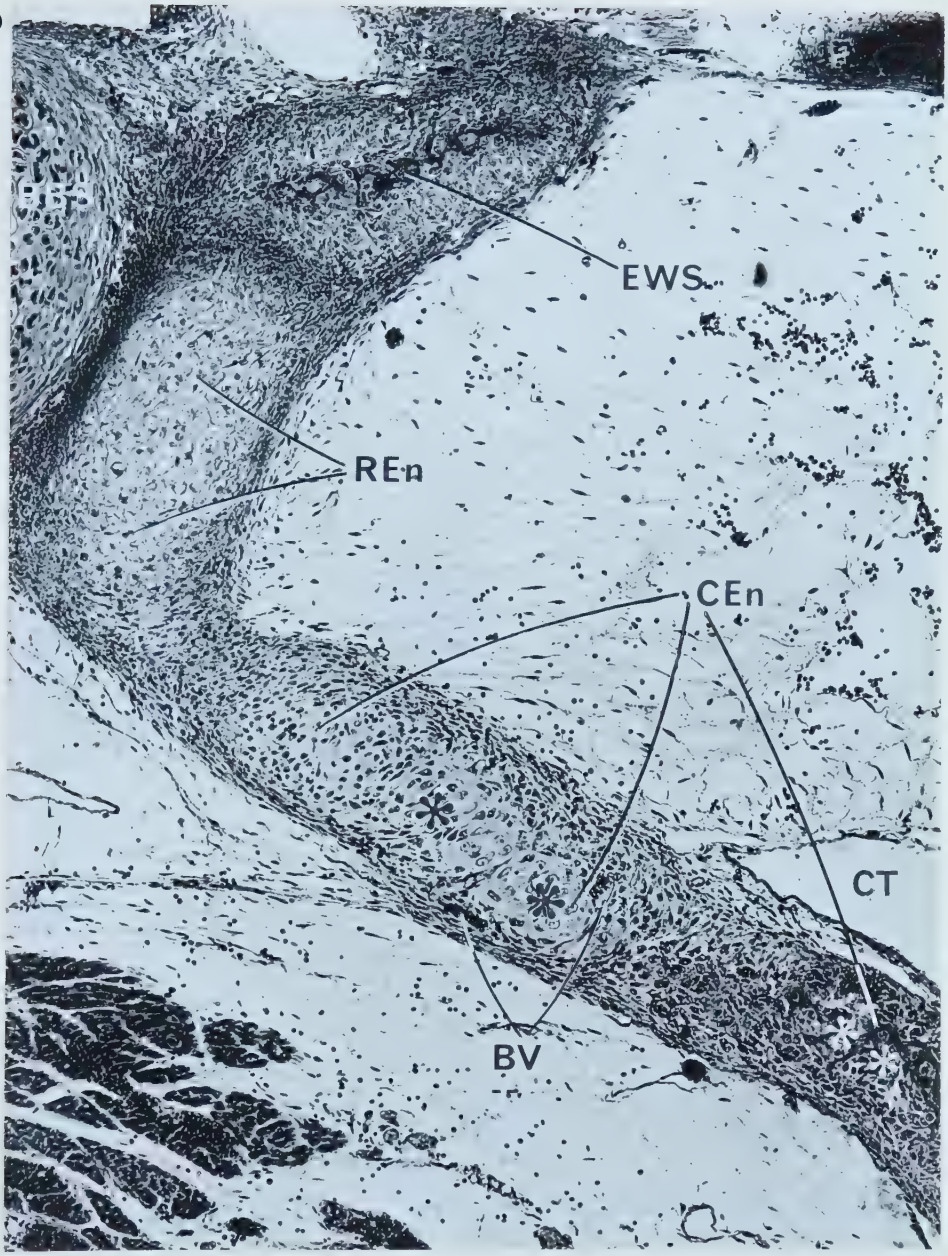
a. s. 1536, cross-section, left side; Periodic Acid-Schiff with Alcian Blue; x 117.

b. s. 1569, cross-section, left side; Azan; x 117.

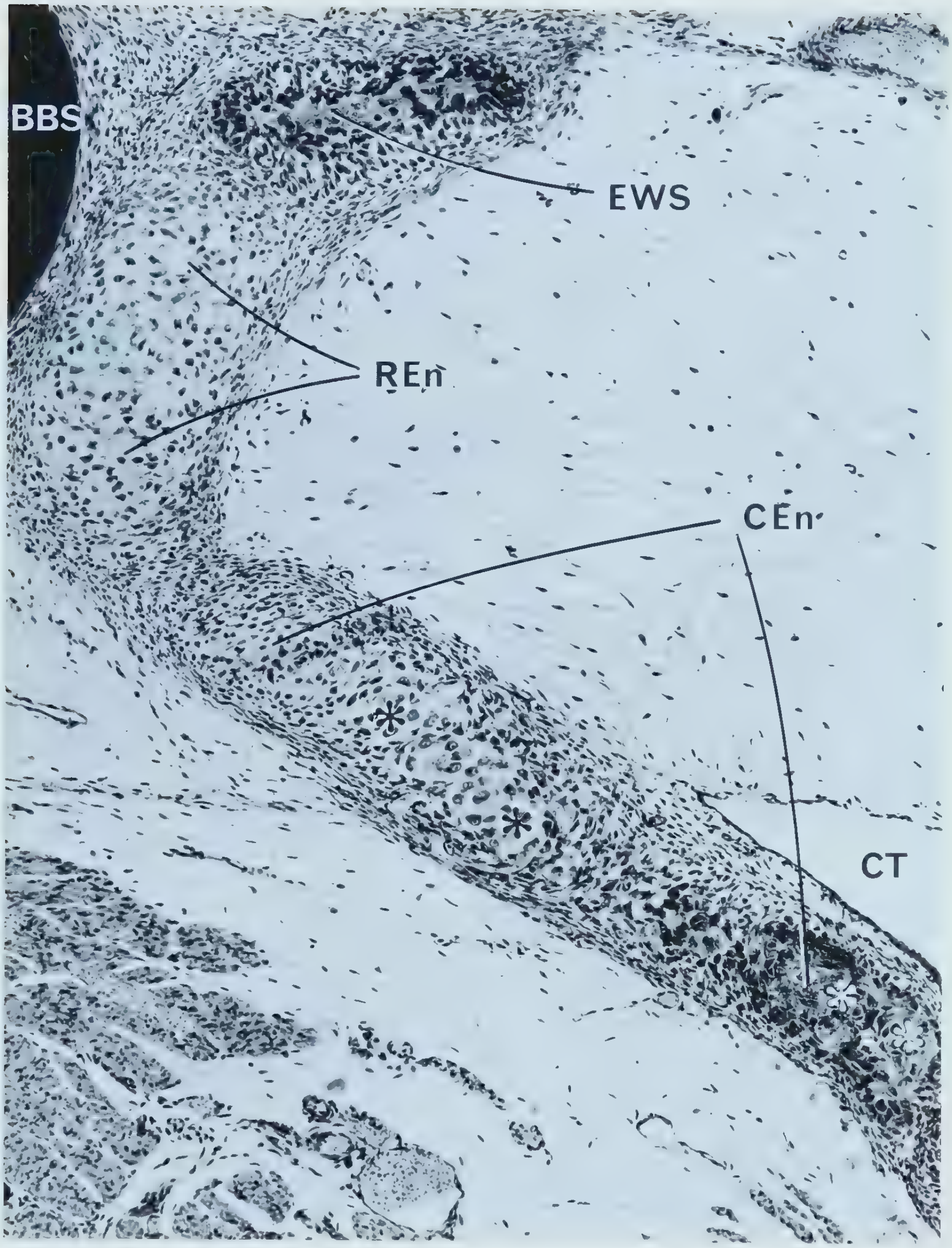
c. s. 1570, cross-section, left side; Cresyl Violet; x 117.


a
BS
REn
CEn
CT
E
SH

b



c



bbb

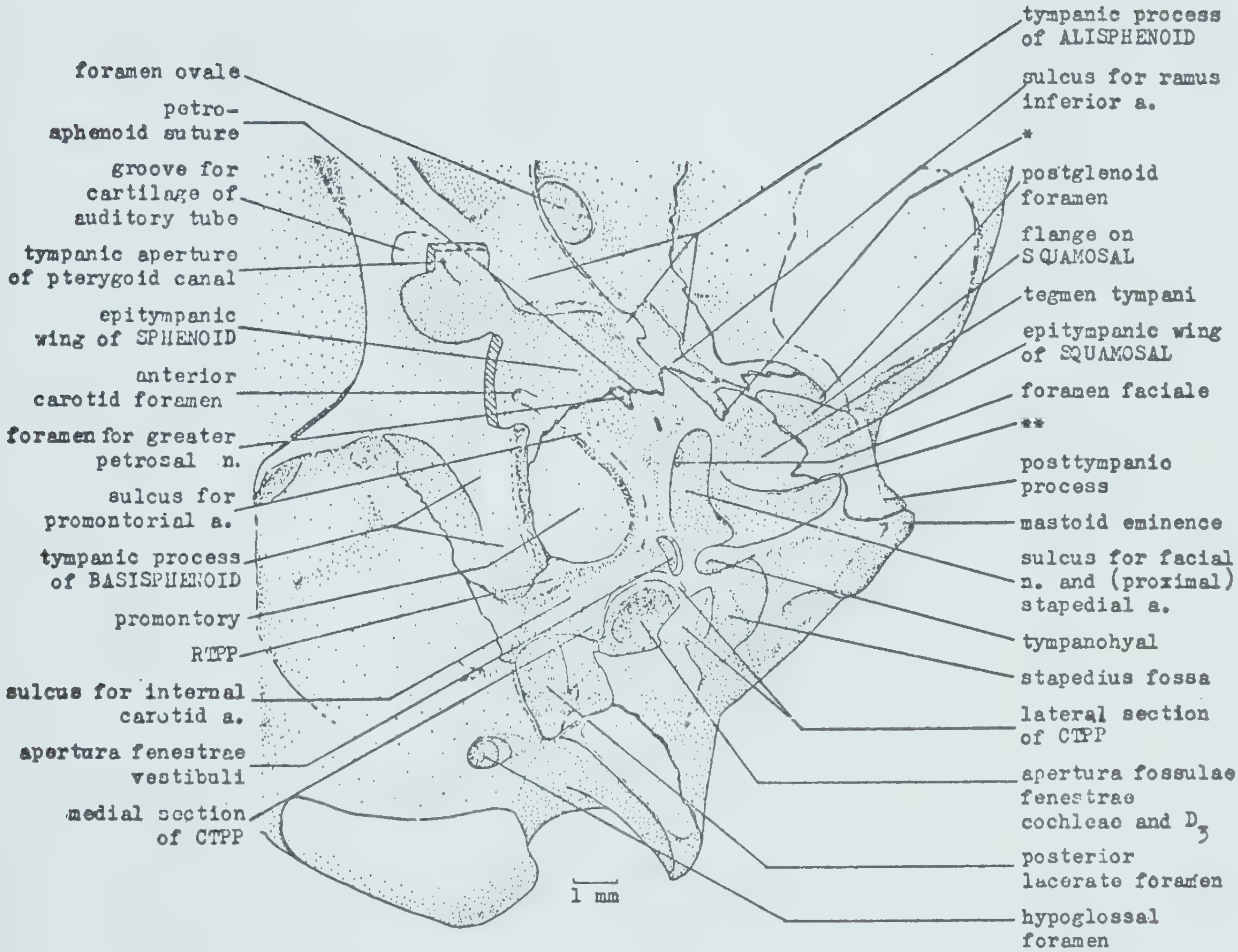
FIG. VI-1 _E. europaeus_ adult. General view of left auditory region, ventral aspect.

a. General anatomy.

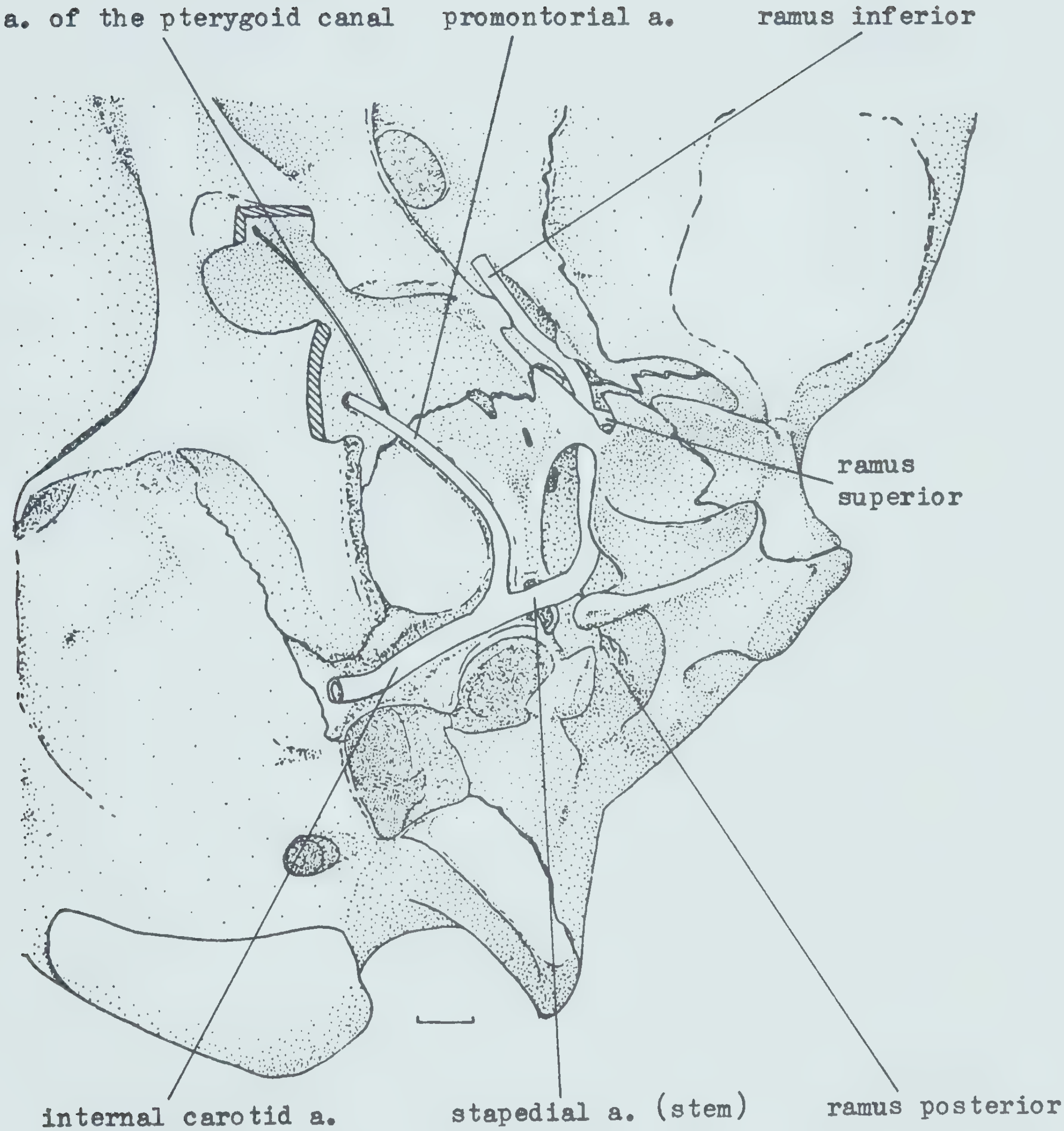
b. Routes of arteries.

The ectotympanic and parts of the tympanic processes of the basisphenoid and alisphenoid have been removed (cf. fig. VI-2). The flange of the squamosal may represent part of the entoglenoid. All that remains of the piriform fenestra is the very large foramen for the greater petrosal n.

*, foramen for ramus superior a. (partly occluded by projecting ridge on tegmen tympani; **, so-called _Chordafortsatz;_ separates epitympanic recess from the accessory cavity excavating a small part of the mastoid eminence.


tympanic process of ALISPHENOID
foramen ovale
sulcus for ramus inferior a.
petro-sphenoid suture
*
groove for cartilage of auditory tube
postglenoid foramen
flange on SQUAMOSAL
tympanic aperture of pterygoid canal
tegmen tympani
epitympanic wing of SPHENOID
epitympanic wing of SQUAMOSAL
anterior carotid foramen
foramen faciale
foramen for greater petrosal n.
**
posttympanic process
sulcus for promontorial a.
mastoid eminence
tympanic process of BASISPHENOID
sulcus for facial n. and (proximal) stapedial a.
promontory
tympanohyal
RTPP
stapedius fossa
sulcus for internal carotid a.
lateral section of CTPP
apertura fenestrae vestibuli
apertura fossulae fenestrae cochleae and D_3
medial section of CTPP
posterior lacerate foramen
1 mm
hypoglossal foramen

7


a. of the pterygoid canal
promontorial a.
ramus inferior
ramus
superior
internal carotid a.
stapedial a. (stem)
ramus posterior

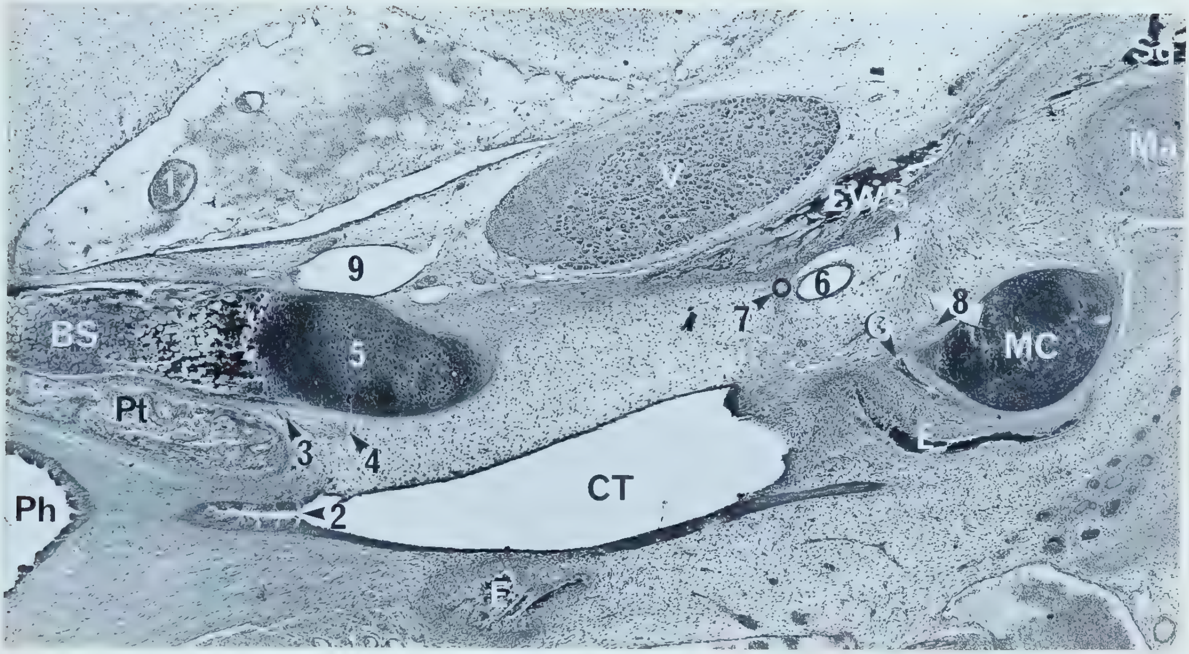
b

FIG. VI-2 *E. europaeus* adult. This illustration is identical to fig. VI-1, except that here all structures are complete and the ectotympanic is *in situ*. The ectotympanic is semiphaneric; part of its medial portion is covered by the tympanic process of the basisphenoid.

FIG. VI-3 _E. europaeus_ MPIH 1964/52b (newborn); s. 1000, cross-section, left side; Klüver-Barrera; x 32.

Anterior end of presumptive tympanic cavity. The pterygoid is fused to the basisphenoid by this stage, but it is still free in the near-term fetus (MPIH 1964/58a; not illustrated).

1, promontorial a. (cerebral carotid a.); 2, lumen of auditory tube; 3, a. of pterygoid canal; 4, nerves of pterygoid canal; 5, ala temporalis and processus alaris; 6, ramus inferior of the stapedial a; 7, lesser petrosal n.; 8, chorda tympani; 9, cavernous sinus; 10, FMTC.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MC
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3
4
CT
Ph
2
E
E
Ma

673

FIG. VI-4 _E. europaeus_ MPIH 1964/52b (newborn); s. 1040, cross-section, right side (sides rev.); Klüver-Barrera; x 32.

Promontorial a. within foramen caroticum primitivum. Note small a. of the pterygoid canal.

For key to numbered structures, see fig. VI-3.


9
V
EWS
Sq
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BS
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2
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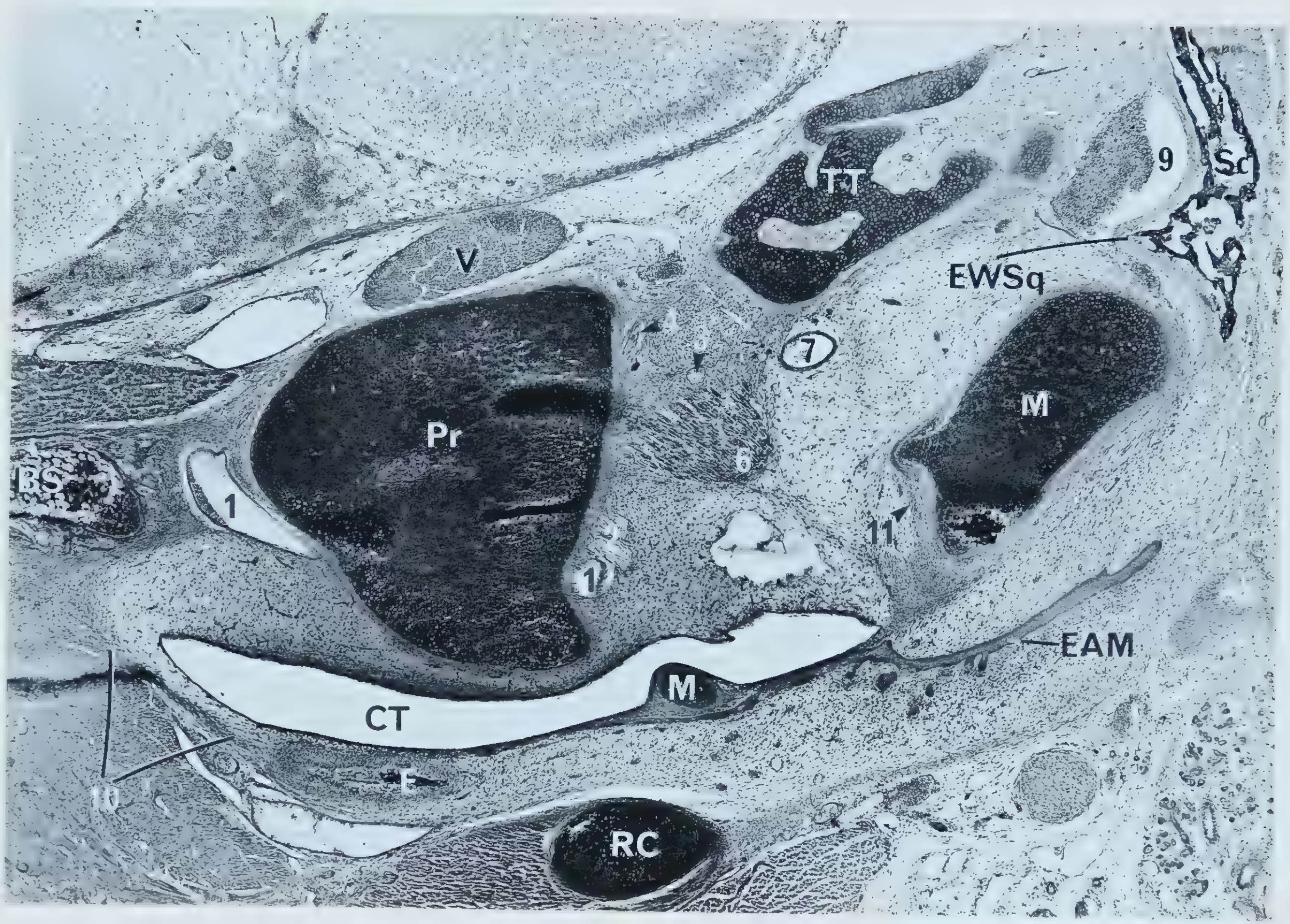
7
8
3
4
MC
G
Ph
E
CT
10
F

675

FIG. VI-5 E. europaeus MPIH 1964/52b (newborn); s. 1040, cross-section, left side; Klüver-Barrera; x 32.

Anterior pole of promontory. Note peculiar, labyrinthine appearance of tegmen tympani.

1, promontorial a.; 2, internal carotid n.; 3, lesser petrosal n.; 4, greater petrosal n.; 5, geniculate ganglion; 6, tensor tympani m.; 7, ramus inferior of the stapedial a.; 8, ramus superior of the stapedial a.; 9, petrosquamous sinus; 10, fibrous membrane of tympanic cavity; 11, chorda tympani.


Sc
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EWSq
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11
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EAM
M
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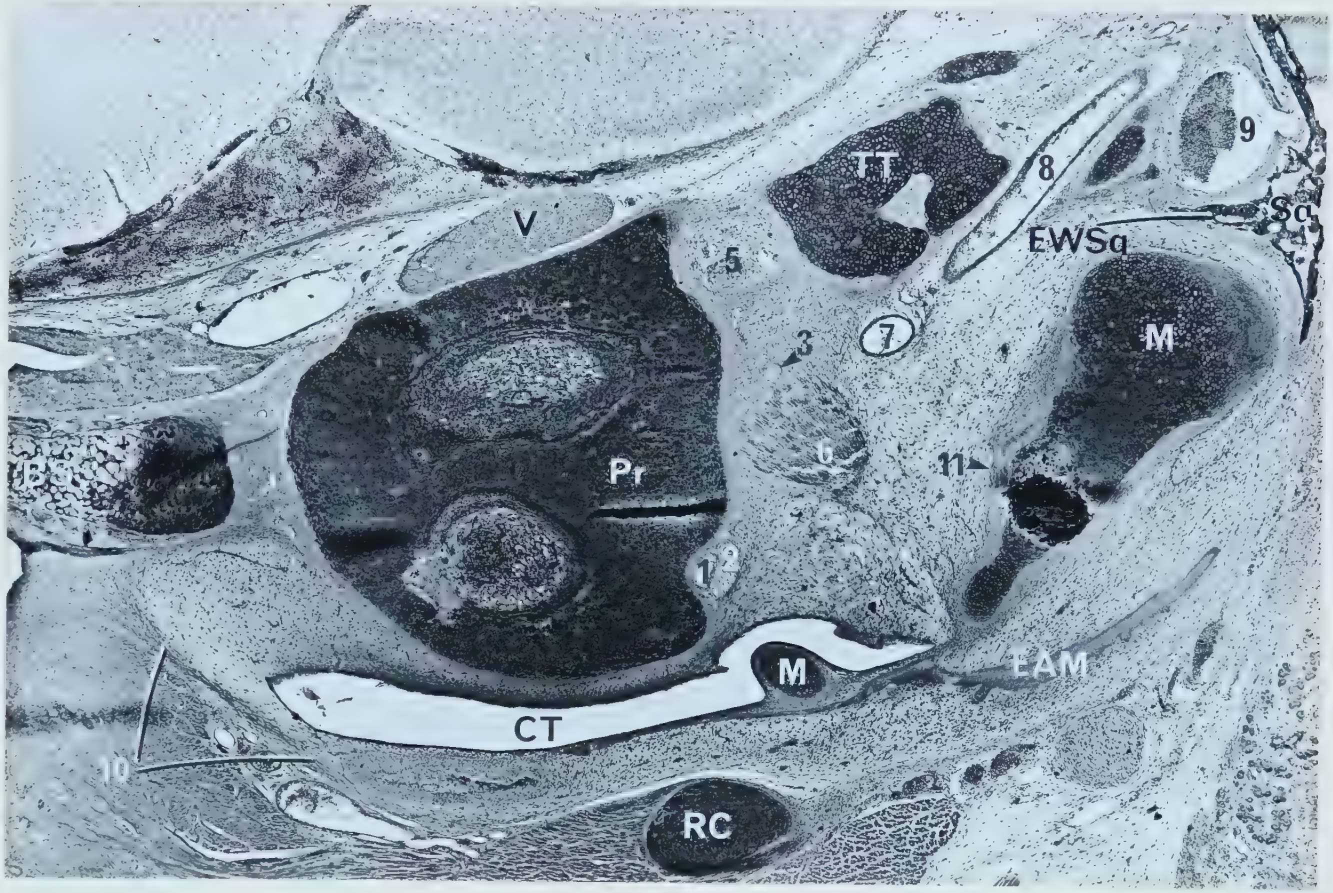
10
E
RC

677

FIG. VI-6 *E. europaeus* MPIH 1964/52b (newborn); s. 1050, cross-section, left side; Klüver-Barrera; x 32.

Anterior pole of promontory.

For key to numbered structures, see fig. VI-5.


V
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EWSq
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EAM
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679

FIG. VI-7 E. europaeus MPIH 1964/52b (newborn); s. 1170, cross-section, right side (sides rev.); Klüver-Barrera; x 32.

Proximal portion of the ramus posterior of the stapedial a., near its origin.

1, internal carotid a.; 2, cavum tympani; 3, ramus posterior of the stapedial a.; 4, FMTC; 5, stapedius m.; 6, CTPP (lateral section); 7, posterior continuation of crista parotica.

FIG. VI-8 E. europaeus MPIH 1964/57 (4 days old); s. 1400, cross-section, left side; Klüver-Barrera; x 44.

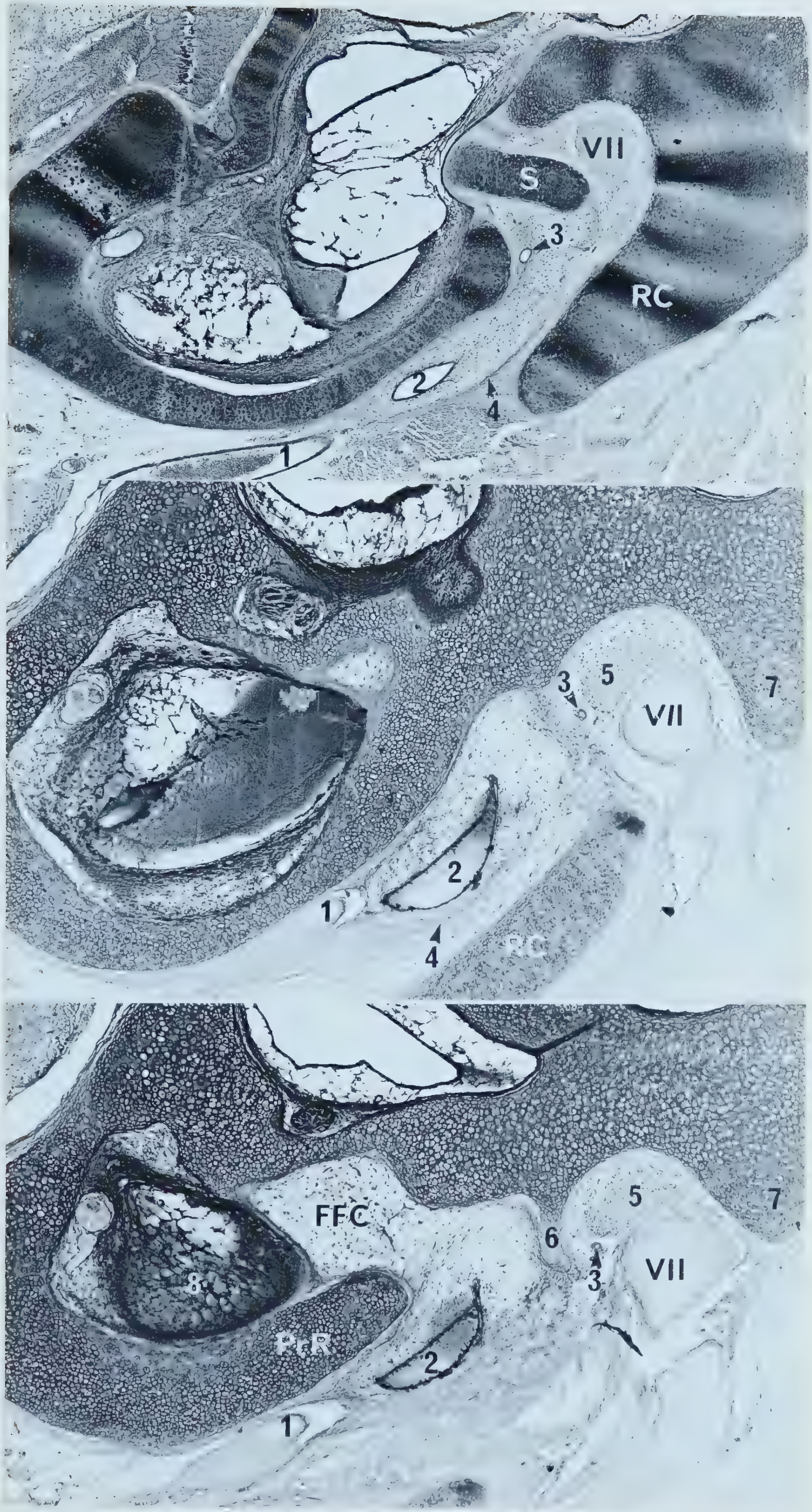
Facial n. within foramen stylomastoideum primitivum. Note small ramus posterior of the stapedial a.

For key to numbered structures, see fig. VI-7.

FIG. VI-9 E. europaeus MPIH 1964/57 (4 days old); s. 1410, cross-section, left side; Klüver-Barrera; x 44.

This and the following figure illustrate the relationships of the medial and lateral sections of the caudal tympanic process of the petrosal to various structures.

For key to numbered structures, see fig. VI-7.


VII
S
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RC
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4
1
3
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7
VII
2
1
4
RC
FFC
5
7
6
VII
3
8
PtR
2
1

681

FIG. VI-10 _E. europaeus_ MPIH 1964/57 (4 days old).

a. s. 1420, cross-section, left side; Klüver-Barrera; x 44.

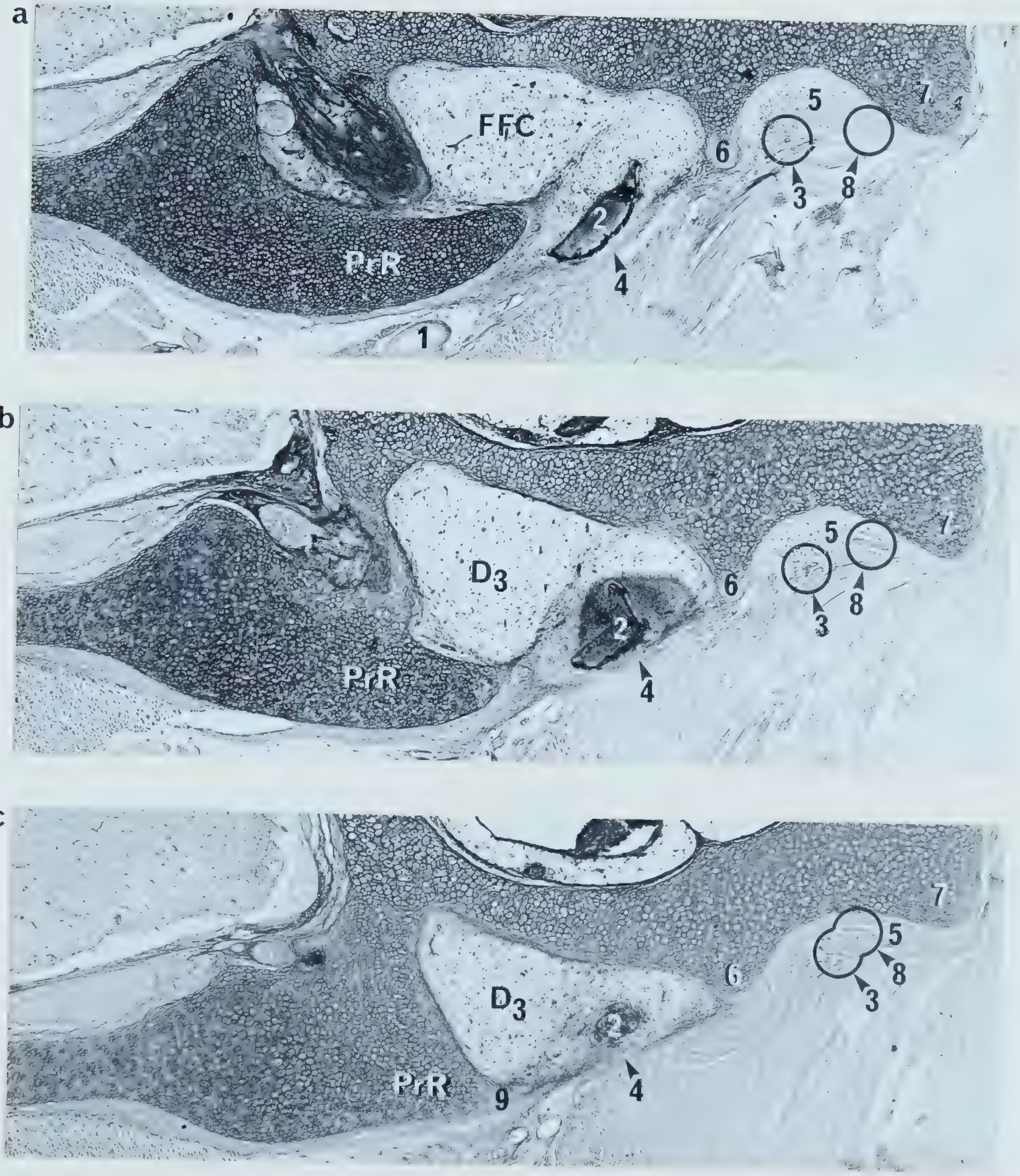
b. s. 1430, cross-section, left side; Klüver-Barrera; x 44.

c. s. 1440, cross-section, left side; Klüver-Barrera; x 44.

Series of sections through the medial and lateral sections of the caudal tympanic process of the petrosal. The lateral section is well-developed, but the medial section (which is a prolongation of the processus recessus) is barely indicated at this stage.

Also visible is ramus posterior of the stapedial a., distributing its terminal branches to the stapedius m. and its investing tissues. The ramus posterior cannot be traced beyond the level represented by fig. VI-10c.

1, internal carotid a.; 2, cavum tympani; 3, ramus posterior of stapedial a.; 4, FMTC; 5, stapedius m. in stapedius fossa; 6, CTPP (lateral section); 7, posterior continuation of crista parotica; 8, auricular ramus of vagus; 9, CTPP (medial section).


a
FFC
PrR
1
2
3
4
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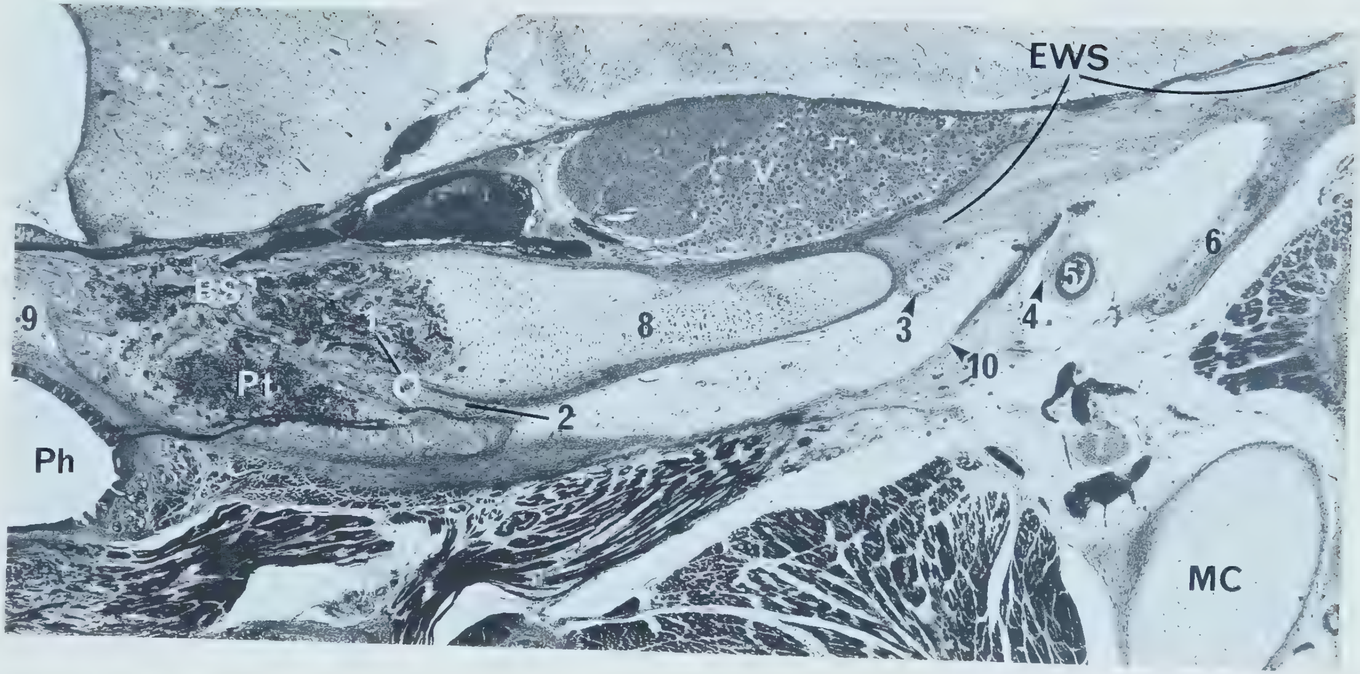
6
7
8
b
D3
PrR
2
3
4
5
6
7
8
c
D3
PrR
2
3
4
5
6
7
8
9

FIG. VI-11 <u>E</u>. <u>europaeus</u> MPIH 1966/146 (young infant); s. 1741, cross-section, right side (sides rev.); Azan; x 32.

Anterior end of presumptive tympanic cavity. The pterygoid is completely fused to the basisphenoid, but the pterygoid canal provides an anatomical boundary between the two.

1, artery of the pterygoid canal; 2, nerves of the pterygoid canal (entering pterygoid canal); 3, tensor tympani m.; 4, lesser petrosal n.; 5, ramus inferior of stapedial a.; 6, wall of sulcus for ramus inferior (part of tympanic process of alisphenoid); 7, chorda tympani; 8, processus alaris and ala temporalis; 9, basisphenoidal pit; 10, FMTC.

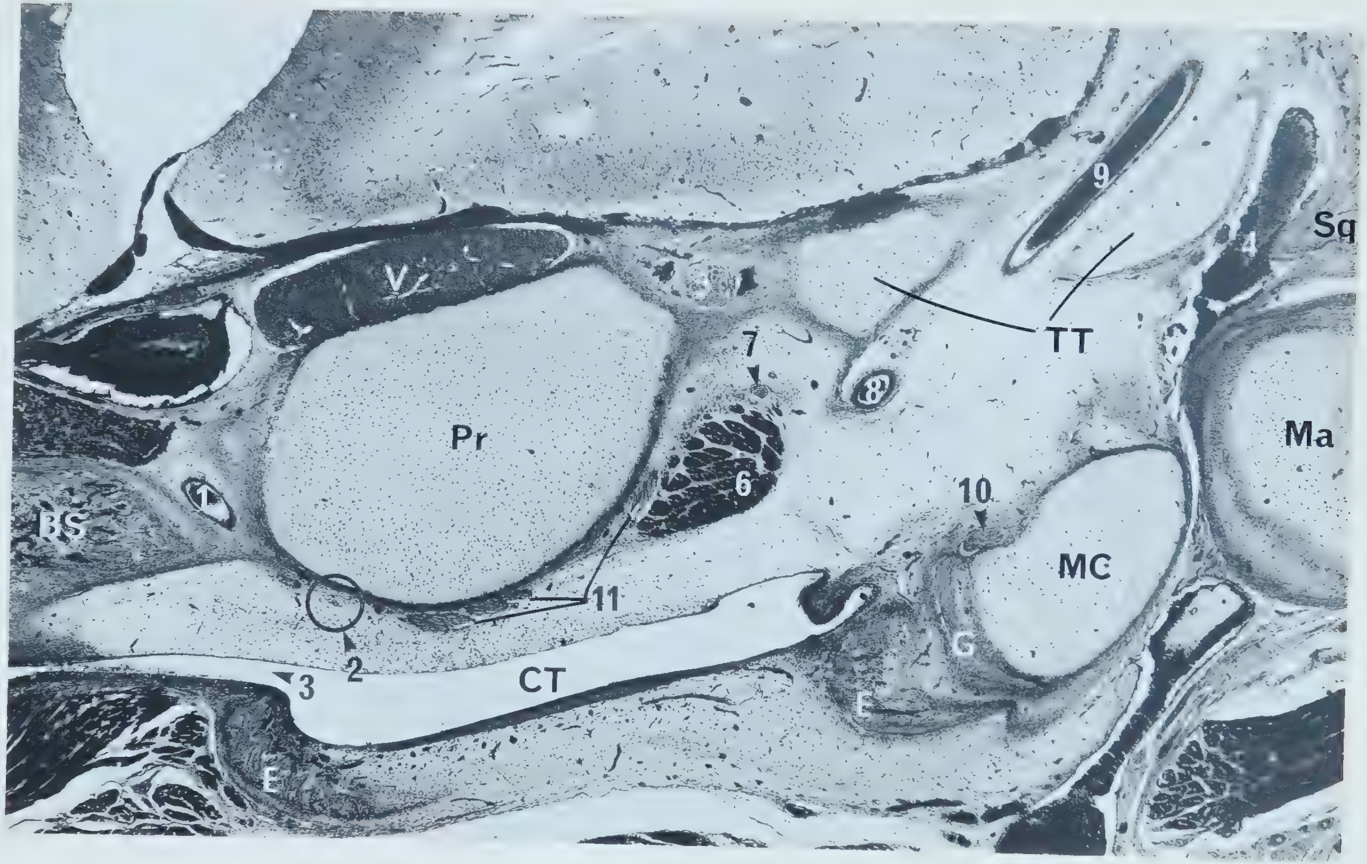

EWS
6
5
4
3
10
8
9
BS
1
Pt
2
Ph
MC

685

FIG. VI-12 *E. europaeus* MPIH 1966/146 (young infant); s. 1801, cross-section, right side (sides rev.); Azan; x 32.

Anterior pole of promontory and tegmen tympani.

1, promontorial a.; 2, artery of pterygoid canal; 3. lumen of auditory tube; 4, petrosquamous sinus; 5, geniculate ganglion; 6, tensor tympani; 7, lesser petrosal n.; 8, ramus inferior of stapedial a.; 9, ramus superior of stapedial a.; 10, chorda tympani; 11, tympanic plexus (greater petrosal and deep petrosal nn.).


Sq
9
4
TT
V
7
8
Pr
Ma
6
10
BS
1
MC
11
2
G
3
CT
E
E

687

FIG. VI-13 *E. europaeus* MPIH 1966/146 (young infant); s. 1891, cross-section, right side (sides rev.); Azan.

a. Section through tympanic process of basisphenoid; x 32.

b. Enlargement of part of fig. VI-13a; x 108.

1, chorda tympani; 2, (proximal) stapedial a.; 3, internal carotid a.; 4, internal carotid n.; 5, lesser petrosal n.; 6, tensor tympani; 7, auricular cartilage.

a

689

b

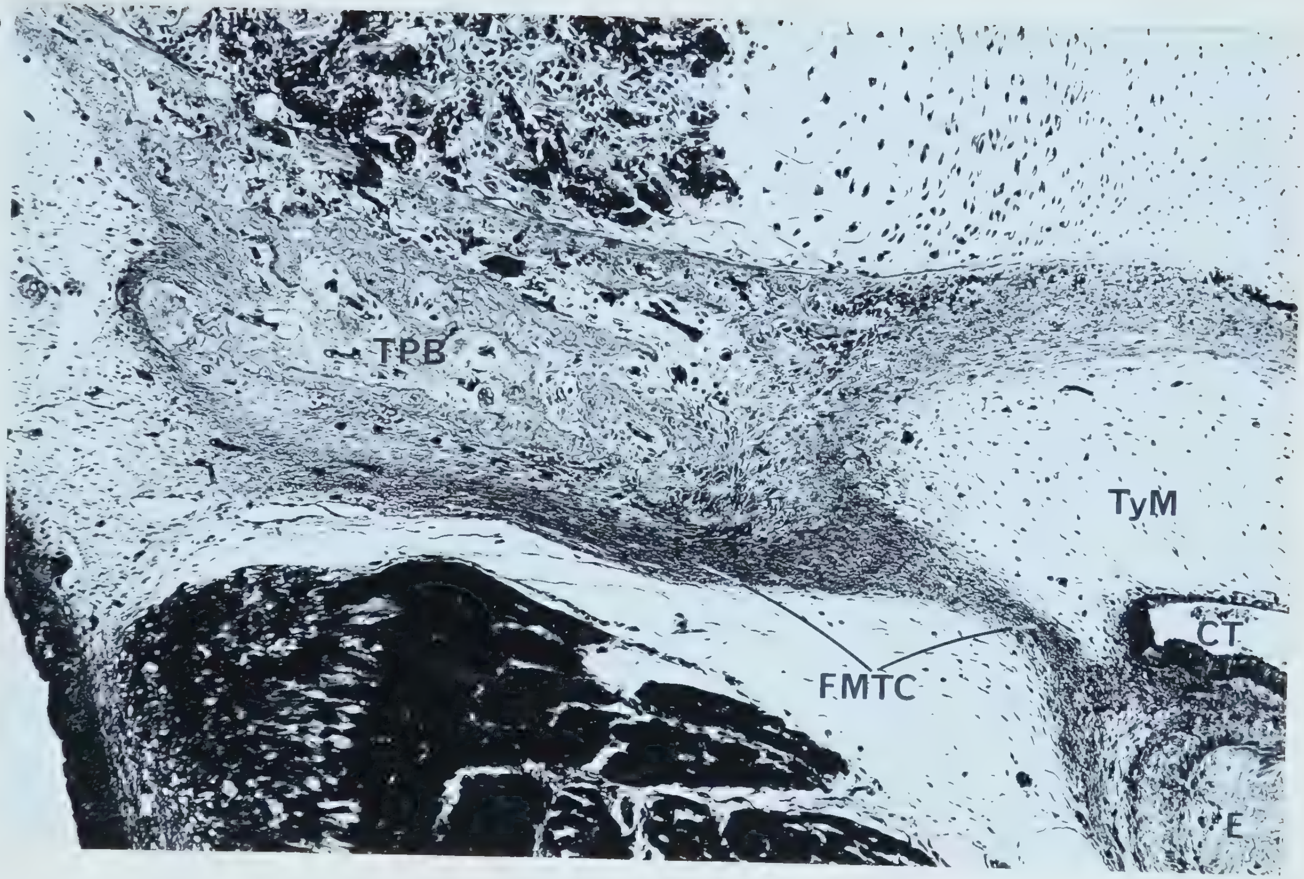


FIG. VI-14 _E. europaeus_ MPIH 1966/146 (young infant); s. 1981, cross-section, left side; Azan; x 32.

Section illustrating massive size of crista parotica.

1, (proximal) stapedial a.; 2, internal carotid a.; 3, tendon of stapedius m.; 4, chorda tympani; 5, FMTC; 6, internal carotid n.; 7, external acoustic meatus; 8, anular ligament of stapes in fenestra vestibuli.

LSC
VII
CrP
1
3
2
6
4
7
CT
7
5
E
RC

FIG. VI-15 E. europaeus MPIH 1966/146 (young infant); s. 1991, cross-section, left side; Azan; x 32.

This and the following three figures illustrate the relationships of the medial and lateral sections of the caudal tympanic proce of the petrosal to various structures.

1, CTPP; 2, internal carotid a.; 3, tendon of stapedius m.; 4, chorda tympani; 5, FMTC; 6, internal carotid n.; 7, tympanic n. joining internal carotid n.

LSC
VII
CrP
1
3
4
2
6
Pr
CT
5
E
RC

FIG. VI-16 *E. europaeus* MPIH 1966/146 (young infant); s. 2001, cross-section, left side; Azan; x 32.

Lateral section of caudal tympanic process of the petrosal.

For key to numbered structures, see fig. VI-15.


LSC
CrP
3
1
2
Pr
CT
4
5
RC

696

FIG. VI-17 E. europaeus MPIH 1966/146 (young infant); s. 2011, cross-section, left side; Azan; x 32.

Lateral section of caudal tympanic process of the petrosal; the process almost meets Reichert's cartilage.

For key to numbered structures, see fig. VI-15.

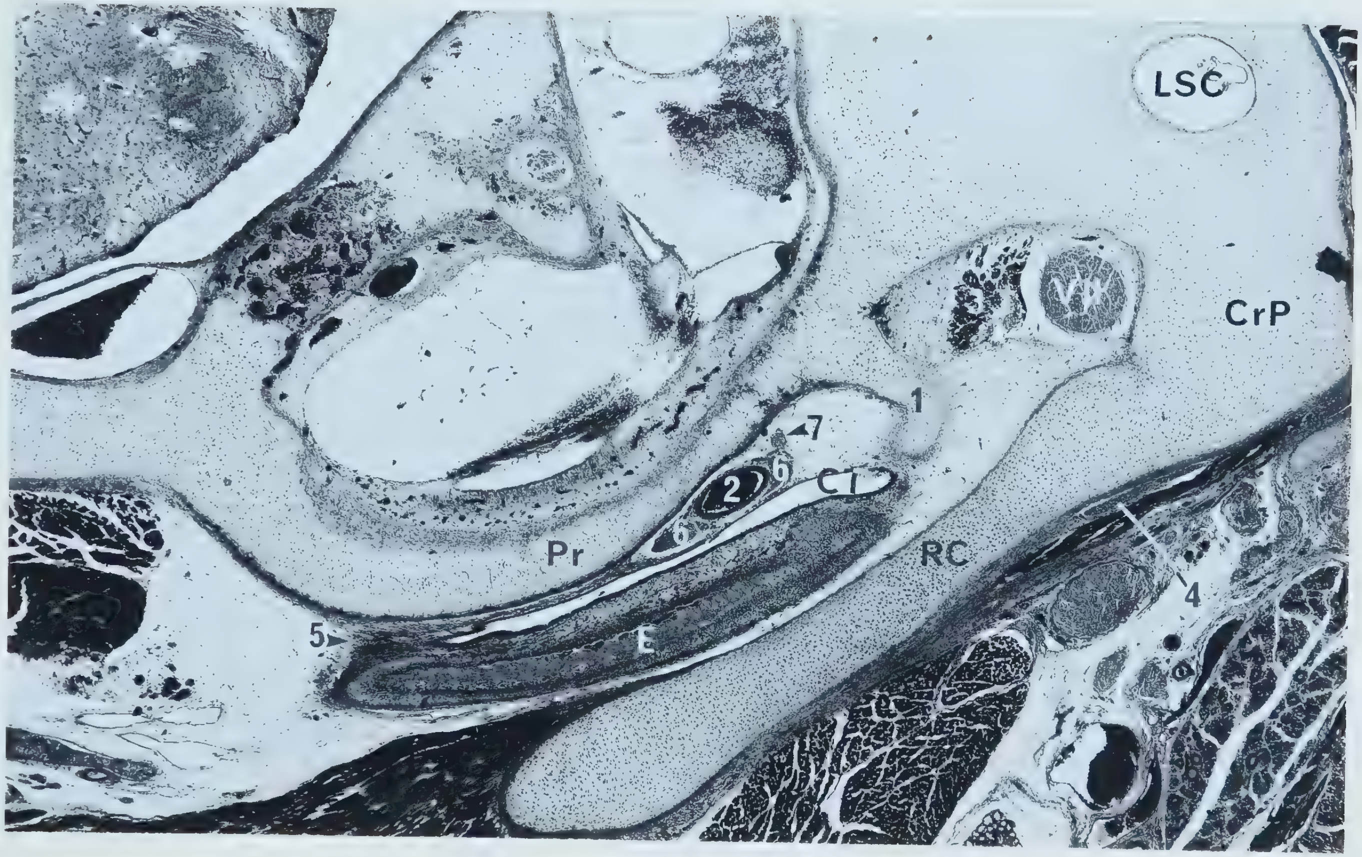

LSC
CrP
VII
1
7
6
2
CT
6
Pr
RC
4
5
E

FIG. VI-18 _E. europaeus_ MPIH 1966/146 (young infant).

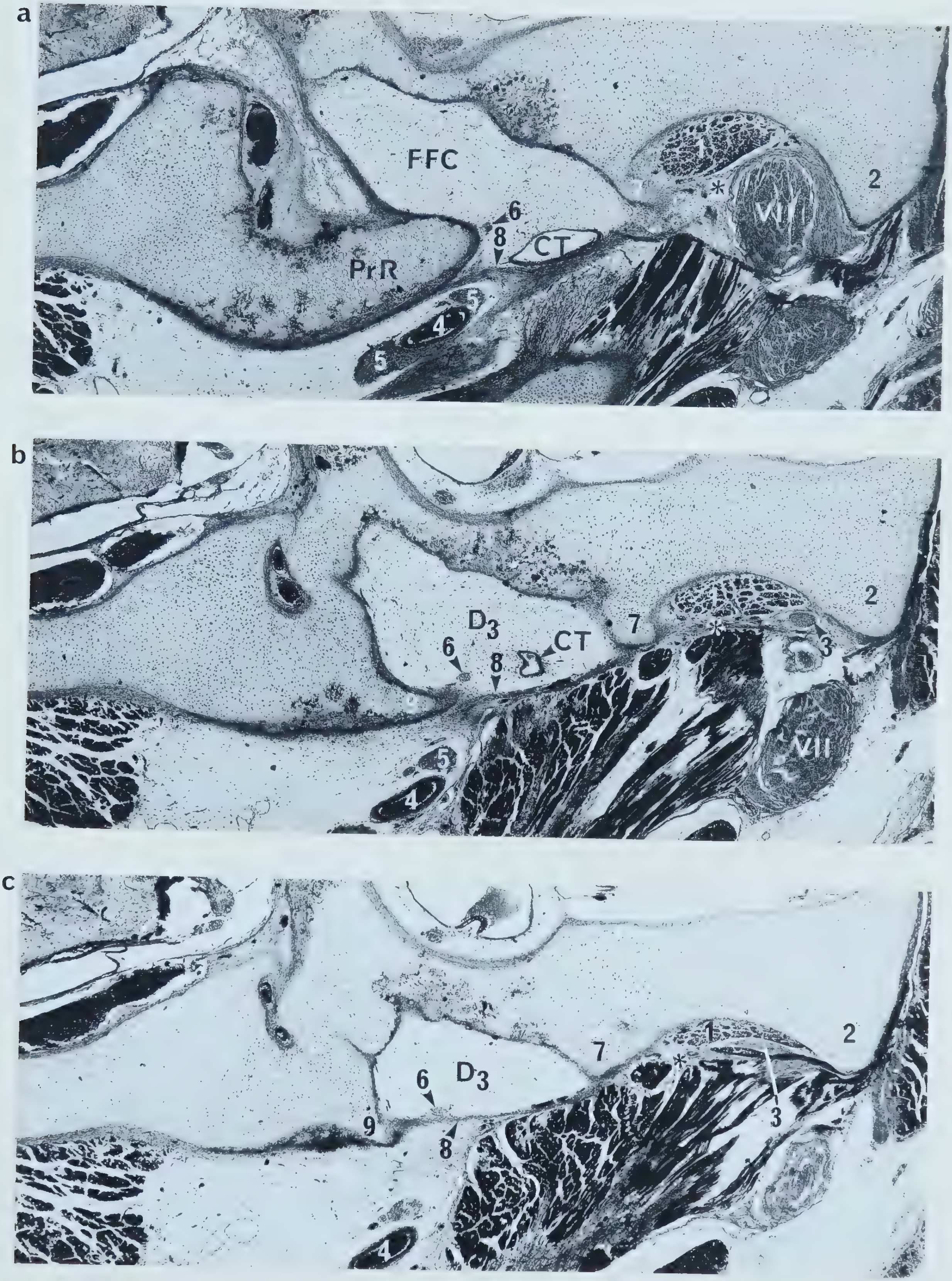
a. s. 2051, cross-section, left side; Azan; x 32.

b. s. 2071, cross-section, left side; Azan; x 32.

c. s. 2081, cross-section, left side; Azan; x 32.

Series of sections through the medial and lateral sections of the caudal tympanic process of the petrosal. The medial section is somewhat better-developed than in MPIH 1964/57 (cf. fig. VI-10), but it is still very small. The ramus posterior of the stapedial a. is represented only by a leash of small vessels beneath the stapedius m. (asterisks).

1, stapedius m.; 2, posterior continuation of crista parotica; 3, auricular ramus of the vagus n.; 4, internal carotid a.; 5, internal carotid n.; 6, tympanic n.; 7, CTPP (lateral section); 8, FMTC; 9, CTPP (medial section).

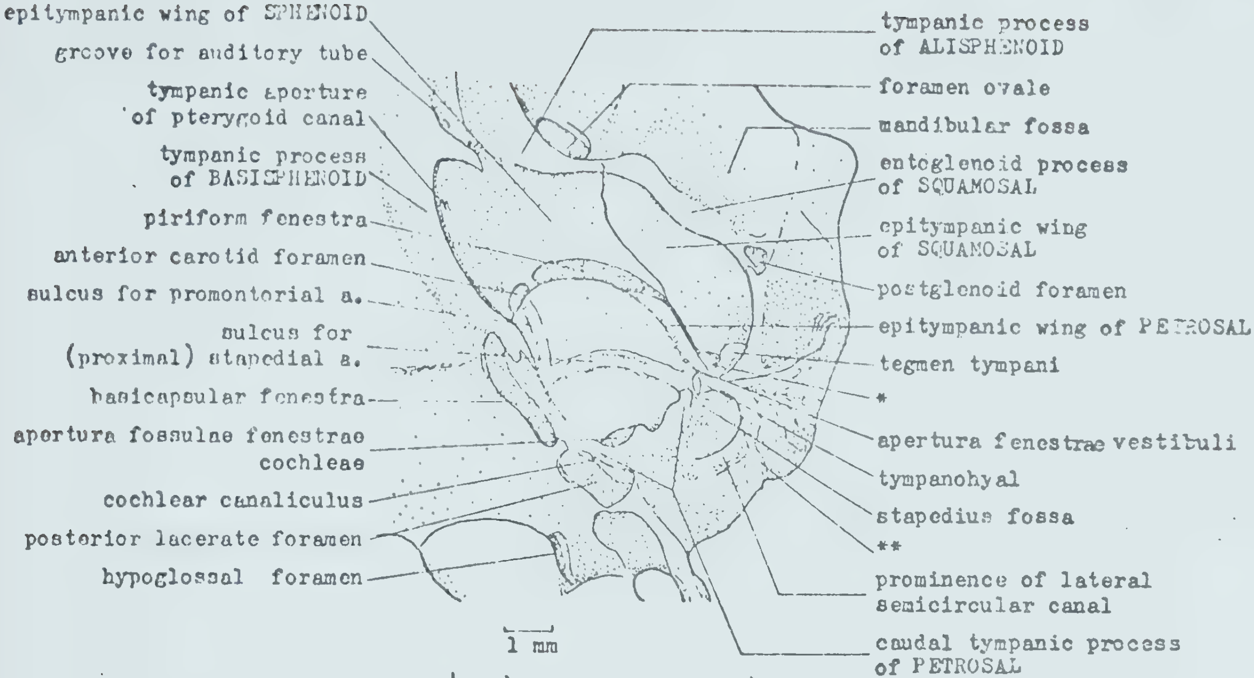

a
FFC
6
8
CT
PrR
5
4
5
VII
2
b
D3
6
8
CT
7
3
2
5
4
VII
c
D3
6
8
9
7
1
2
3
4

700

FIG. VII-1 M. dobsoni adult. General view of left auditory region, ventral aspect.

In the upper figure, the ectotympanic and parts of the tympanic process of the basisphenoid and caudal tympanic process of the petrosal have been removed in order to expose hidden structural details. In the middle figure, all bones and processes are depicted as complete and in situ. The dashed line represents the boundary between the actual ventral surface of the promontory and the outgrowths arising from it. The low ridge extending along the medial side of the promontory may be a rostral tympanic process of the petrosal. The apertura fossulae fenestrae cochleae and diverticulum D_3 are hidden in both figures by the large caudal tympanic process of the petrosal.

The lower figure depicts the tympanic branchings of the carotid system.


epitympanic wing of SPHENOID
groove for auditory tube
tympanic aperture of pterygoid canal
tympanic process of BASISPHENOID
piriform fenestra
anterior carotid foramen
sulcus for promontorial a.
sulcus for (proximal) stapedial a.
basicapsular fenestra
apertura fossulae fenestrae cochleae
cochlear canaliculus
posterior lacerate foramen
hypoglossal foramen
tympanic process of ALISPHENOID
foramen ovale
mandibular fossa
entoglenoid process of SQUAMOSAL
epitympanic wing of SQUAMOSAL
postglenoid foramen
epitympanic wing of PETROSAL
tegmen tympani
*
apertura fenestrae vestibuli
tympanohyal
stapedius fossa
**
prominence of lateral semicircular canal
caudal tympanic process of PETROSAL
1 mm

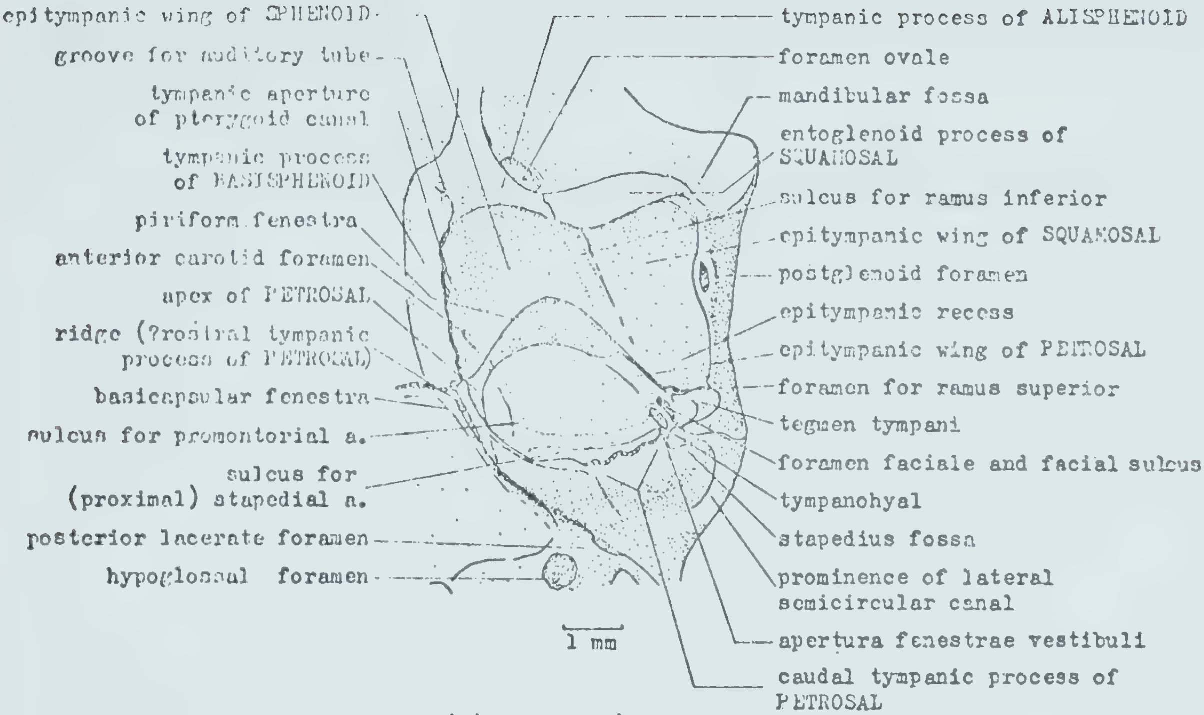

promontorial a.
internal carotid a.
proximal part of stapedial a.
ramus superior
ramus posterior

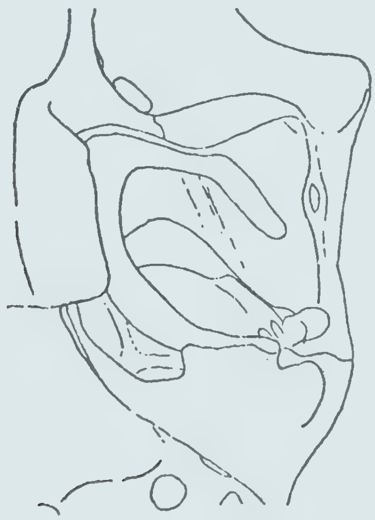
FIG. VII-2 H. semispinosus adult. General view of left auditory region, ventral aspect.

In the upper figure, the ectotympanic and part of the tympanic process of the basisphenoid have been removed in order to expose hidden structural details. The middle figure represents the auditory region prior to dissection. Obvious differences from M. dobsoni (see fig. VII-1) include a smaller caudal tympanic process of the petrosal which does not contact the ectotympanic, isolation of the anterior carotid foramen within the epitympanic wing of the sphenoid, a sulcus for the inferior ramus of the stapedial artery (latter artery not present in M. dobsoni), absence of a medial ridge on the ventral surface of the promontory, and a relatively larger basicapsular fenestra and posterior lacerate foramen.

The lower figure depicts the tympanic branchings of the carotid system.

*, foramen for the ramus superior of the stapedial a., into which the foramen faciale opens; **, groove on mastoid, possibly for ramus posterior of stapedial a.


epitympanic wing of SPHENOID
groove for auditory tube
tympanic aperture of pterygoid canal
tympanic process of BASISPHENOID
piriform fenestra
anterior carotid foramen
apex of PETROSAL
ridge (?rostral tympanic process of PETROSAL)
basicapsular fenestra
sulcus for promontorial a.
sulcus for (proximal) stapedial a.
posterior lacerate foramen
hypoglossal foramen
tympanic process of ALISPHENOID
foramen ovale
mandibular fossa
entoglenoid process of SQUAMOSAL
sulcus for ramus inferior
epitympanic wing of SQUAMOSAL
postglenoid foramen
epitympanic recess
epitympanic wing of PETROSAL
foramen for ramus superior
tegmen tympani
foramen faciale and facial sulcus
tympanohyal
stapedius fossa
prominence of lateral semicircular canal
apertura fenestrae vestibuli
caudal tympanic process of PETROSAL
1 mm



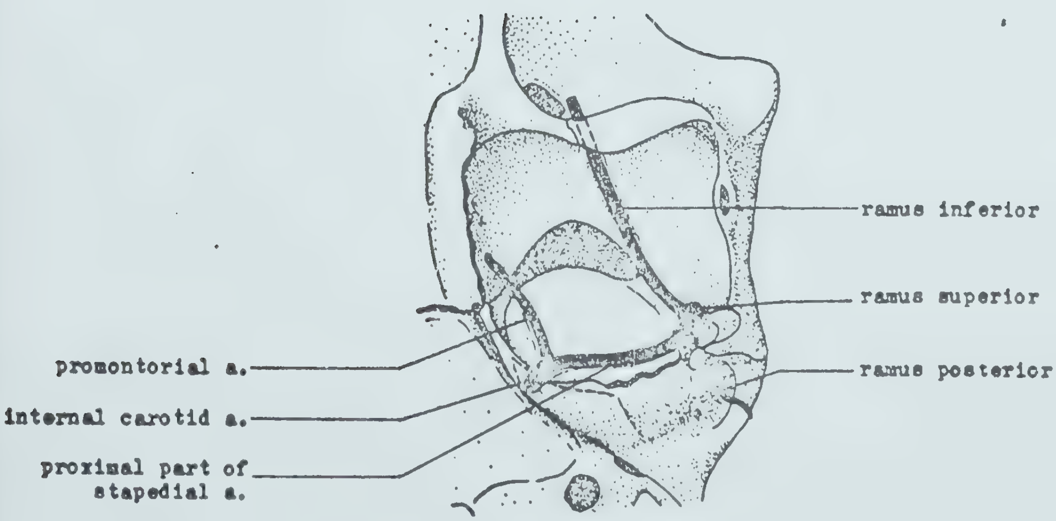

ramus inferior
ramus superior
ramus posterior
promontorial a.
internal carotid a.
proximal part of stapedial a.

FIG. VII-3 Right auditory regions of some tenrecoids (after MCDOWELL 1958). Not to same scale. A, Potamogale velox; B, Limnogale mergulus; C, Microgale (Nesogale) sp.; D, Geogale aurita; E. Echinops telfairi; F, Tenrec ecaudatus; G, Hemicentetes semispinosus.

AC

AC, alisphenoid canal; AV, cochlear canaliculus; CF, posterior carotid foramen or incisure; EF, ethmoidal foramen; EH, tympanohyal; ETR, epitympanic recess; FLA, foramen lacerum anterius (sphenorbital fissure); FLP, foramen lacerum posterius; FPM, anterior process of malleus; FR, apertura fossulae fenestrae cochleae; FSA foramen for ramus superior of stapedial artery; FSM, fossa for stapedius muscle; GCT, groove for chorda tympani; GF, mandibular fossa; HF, hypoglossal foramen; HSC, lateral semicircular canal; IPS, persistent basicapsular fenestra; MA, malleus; NF, foramen for persistent notochord; OF, foramen ovale; PGF, postglenoid foramen; PGP, postglenoid process; PH, hamular process of pterygoid; PP, paroccipital process; PY, persistent piriform fenestra; RI, foramen for ramus inferior and lesser petrosal nerve (or latter only); SMF, foramen stylomastoideum; TP, caudal tympanic process of petrosal; TY, ectotympanic; TYB, tympanic process of basisphenoid or vestige of same.

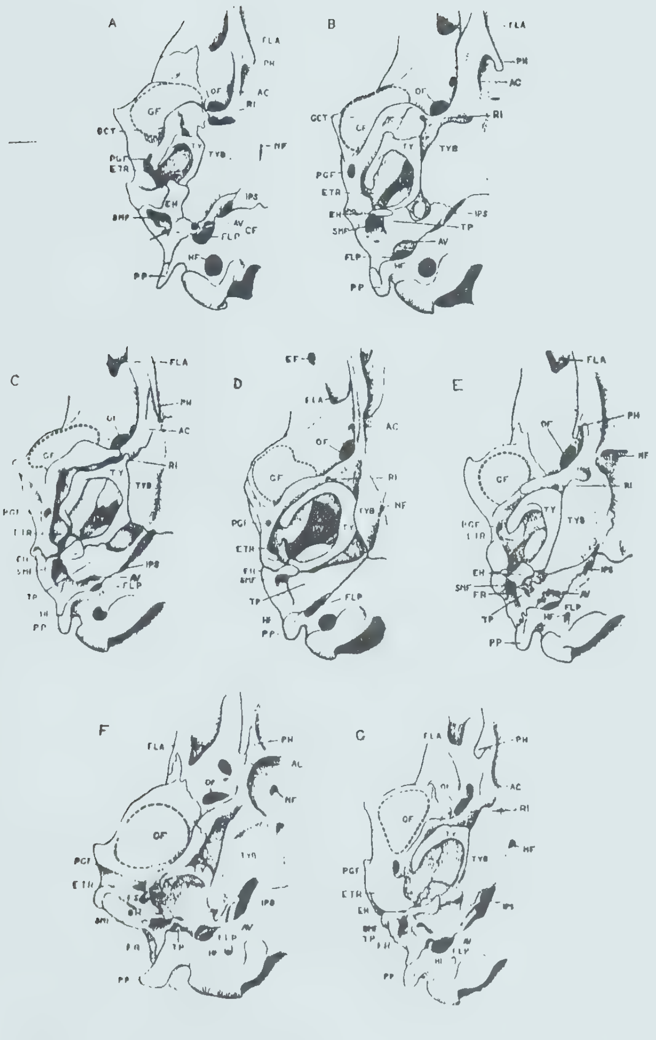
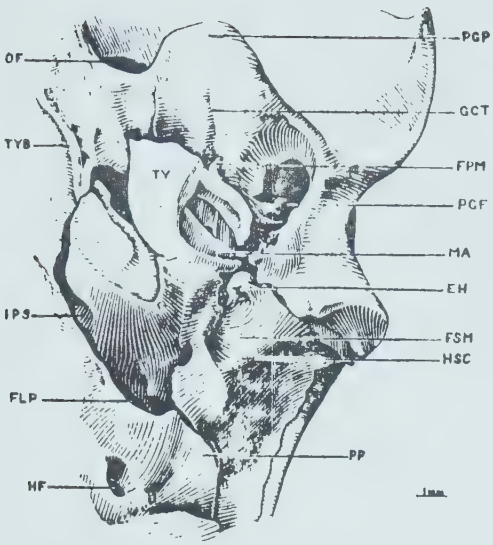
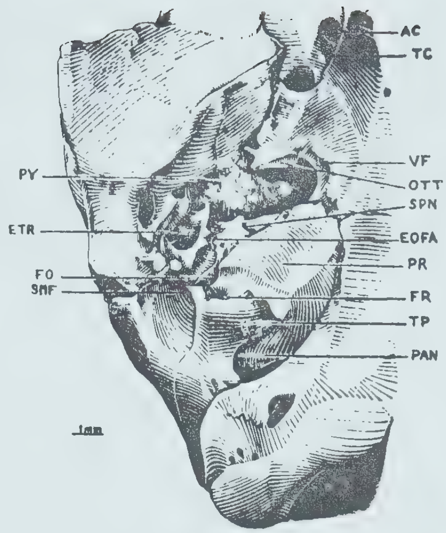


FIG. VII-4 Ventral views of auditory region of _Solenodon paradoxus_ (after MCDOWELL 1958). A, juvenile, with ectotympanic removed; B, adult; C, tympanic branchings of carotid.

AP, promontorial artery; AS, proximal part of stapedial artery; EOFA, foramen faciale; FO, apertura fenestrae vestibuli; ICA, internal carotid artery; OTT, alisphenoid origin of tensor tympani muscle; PAN, passage for auricular ramus of vagus nerve; PR, promontory; RI, ramus inferior of stapedial artery; RP, ramus posterior of stapedial artery; RS, ramus superior of stapedial artery; SPN, foramen for greater petrosal nerve; ST, stapes; TC, transverse canal; VF, tympanic aperture of pterygoid canal. (For key to other named structures, see fig. VIII-3).


OF
TYB
TY
IPS
FLP
HF
PGP
GCT
FPM
PGF
MA
EH
FSM
HSC
PP
1mm

A


AC
TC
VF
OTT
SPN
EOFA
PR
FR
TP
PAN
PY
ETR
FO
SMF
1mm

B

C

FIG. VII-5 H. semispinosus MPIH 1964/84 (fetus); s. 842, cross-section, left side; Klüver-Barrera; x 47.

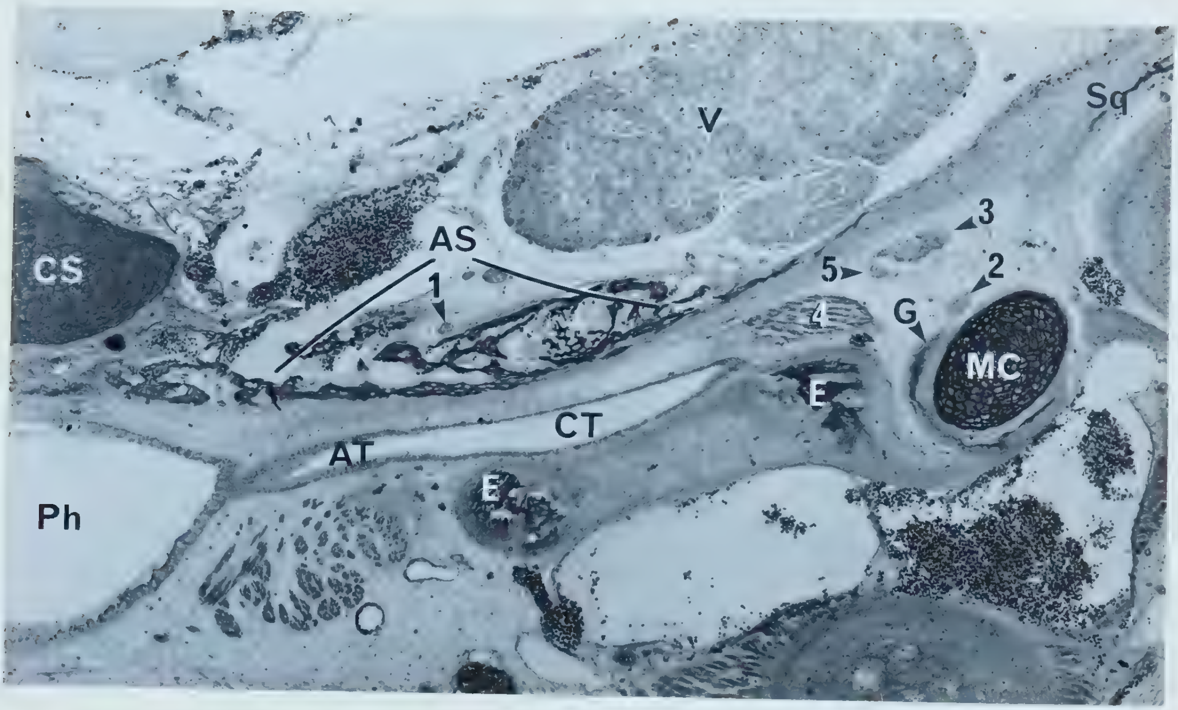
Section through tympanic aperture of auditory tube.

1, nerves of the pterygoid canal; 2, chorda tympani; 3, otic ganglion; 4, tensor veli palatini m.; 5, lesser petrosal n. (to otic ganglion).

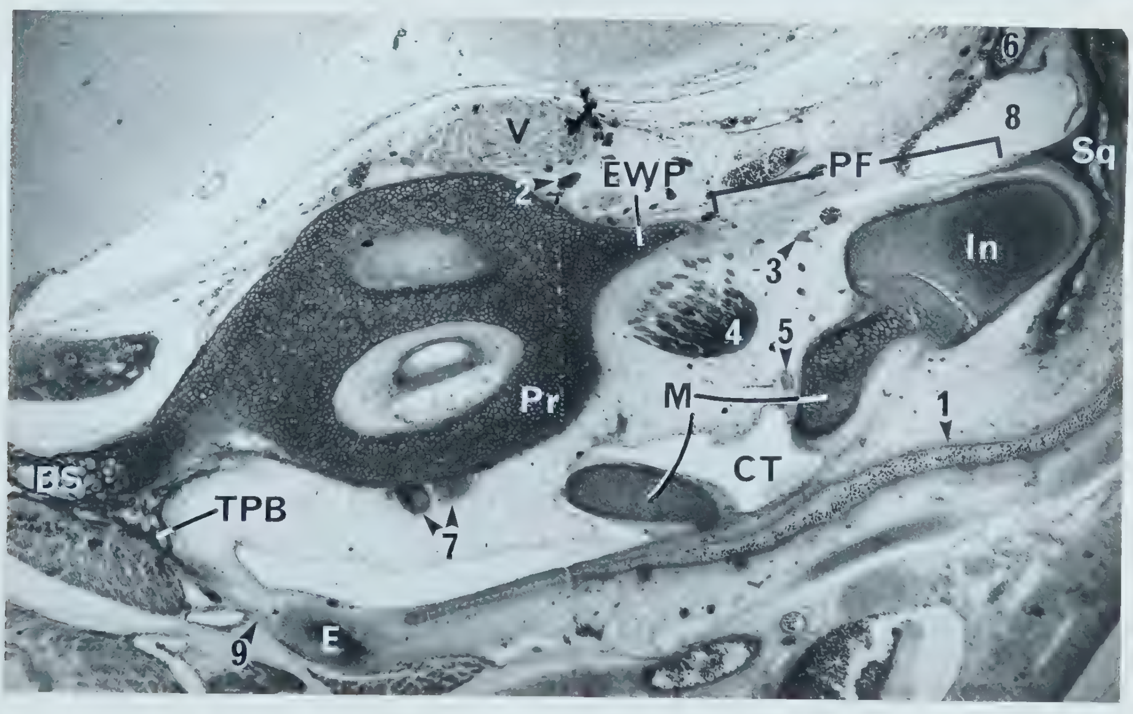
FIG. VII-6 H. semispinosus MPIH 1964/84 (fetus); s. 912, cross-section, left side; Klüver-Barrera; x 47.

Section through mid-part of pars cochlearis. The epitympanic wings of the petrosal and squamosal are both present, but are separated by a wide interval at this stage (posterior section of piriform fenestra).

1, external acoustic meatus; 2, greater petrosal n.; 3, lesser petrosal n.; 4, tensor tympani; 5, chorda tympani; 6, ramus superior of stapedial a. (middle meningeal a.); 7, promontorial a. and internal carotid n.; 8, petrosquamous sinus; 9, FMTC.



V
Sq
3
AS
2
CS
5
1
G
4
MC
E
CT
AT
Ph
E



6
8
V
Sq
EWP
PF
2
In
3
4
5
Pr
M
1
BS
CT
TPB
7
9
E

710

FIG. VII-7 H. semispinosus MPIH 1964/84 (fetus).

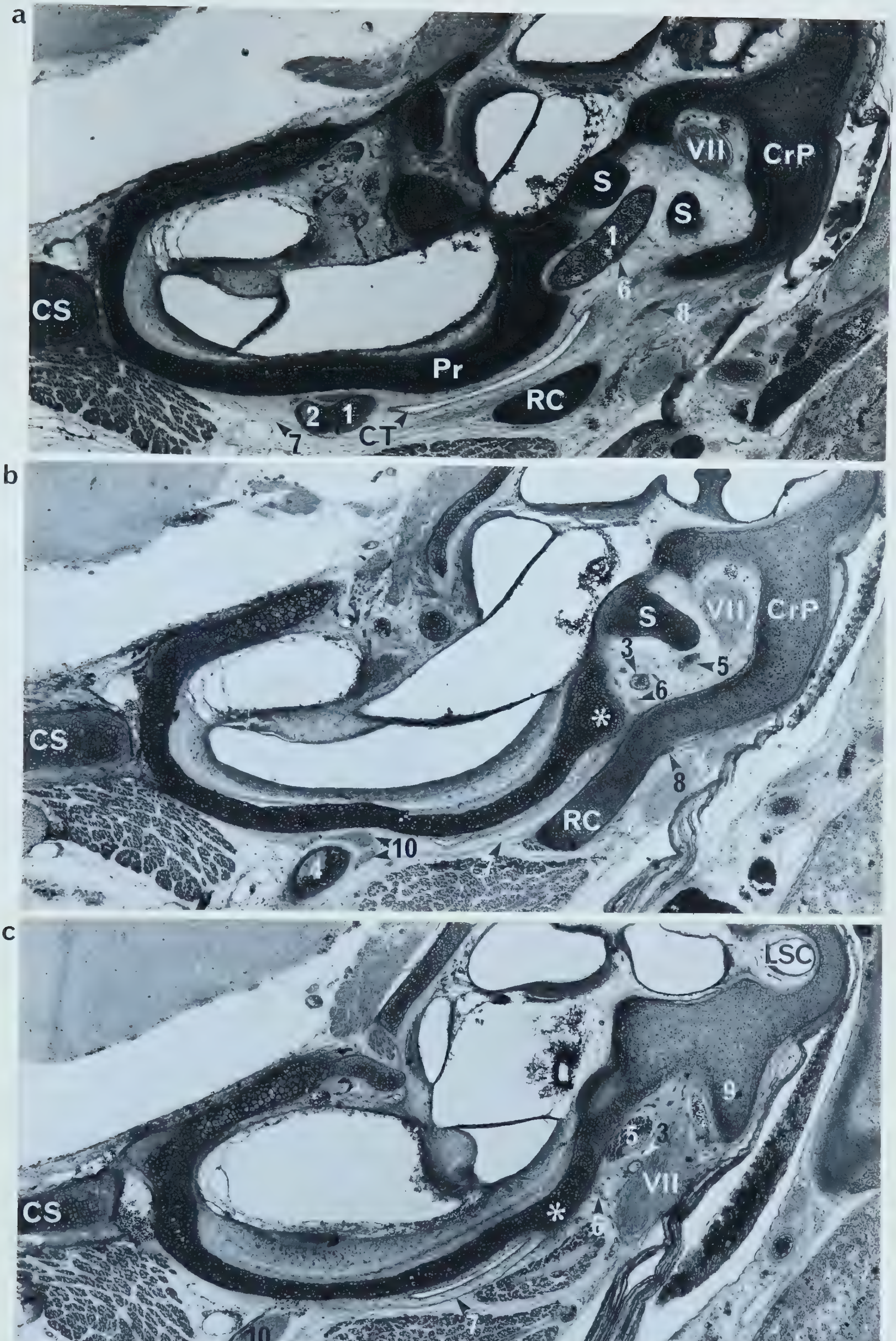
a. s. 982, cross-section, right side (sides rev.); Klüver-Barrera; x 47.

b. s. 992, cross-section, right side (sides rev.); Klüver-Barrera; x 47.

c. s. 1012, cross-section, right side (sides rev.); Klüver-Barrera; x 47.

The lateral section of the caudal tympanic process of the petrosal, in the adult, extends anteriorly as far as the sulcus for the (proximal) stapedial a. In this young specimen, this part of the process is barely distinguishable as a low cartilaginous ridge on the rear of the pars cochlearis (asterisks). Note that the internal carotid a. bifurcates as soon as it enters the presumptive tympanic cavity.

1, stapedial a. (proximal portion); 2, promontorial a.; 3, ramus posterior of the stapedial a.; 5, stapedius m.; 6, tympanic n.; 7, FMTC; 8, chorda tympani; 9, posterior continuation of crista parotica; 10, internal carotid n.


a
VII
CrP
S
S
1
6
8
CS
Pr
RC
2
1
CT
7
b
S
VII
CrP
3
5
6
*
8
CS
RC
10
4
c
LSC
9
5
3
VII
*
6
CS
7
10

712

FIG. VII-8 _H_. _semispinosus_ MPIH 1964/84 (fetus).

a. s. 1022, cross-section, right side (sides rev.); Klüver-Barrera; x 47.

b. s. 1032, cross-section, right side (sides rev.); Klüver-Barrera; x 47.

c. s. 1052, cross-section, right side (sides rev.); Klüver-Barrera; x 47.

From its origin behind the sulcus for the (proximal) stapedial a., the lateral section of the CTPP (asterisks) extends along the posterior pole of the promontory and terminates on the anteroventral surface of the pars canalicularis. The processus recessus posterior has not yet formed.

1, perilymphatic duct; 2, ramus posterior of the stapedial a.; 3, posterior continuation of the crista parotica; 4, stapedius m.; 5, FMTC; 6, internal jugular v.; 7, secondary tympanic membrane; 8, auricular ramus of the vagus; 9, tympanic n.

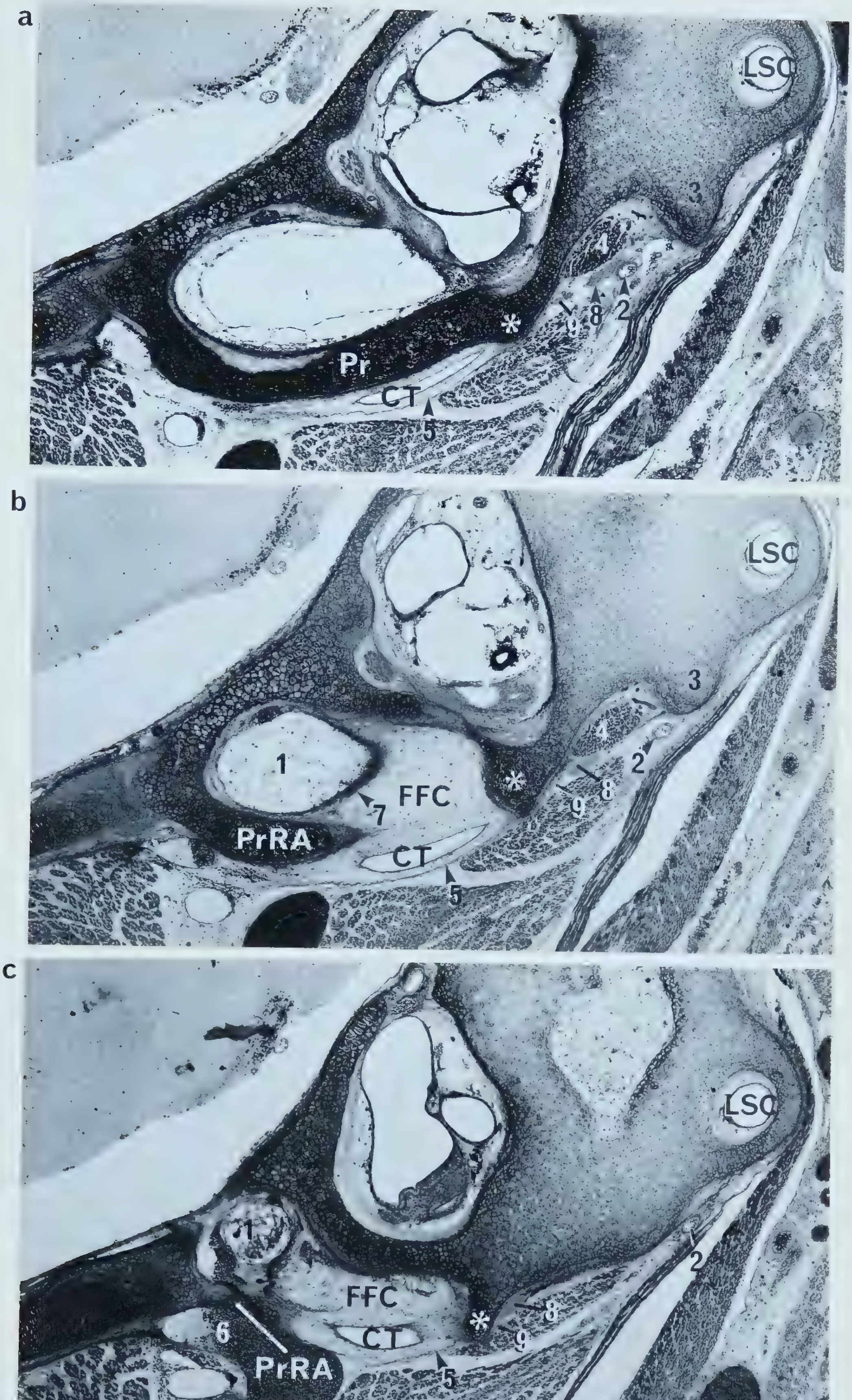

a
LSC
3
4
9
8
2
*
Pr
CT
5
b
LSC
3
4
2
1
FFC
*
9
8
7
PrRA
CT
5
c
LSC
1
2
FFC
*
8
9
6
CT
PrRA
5

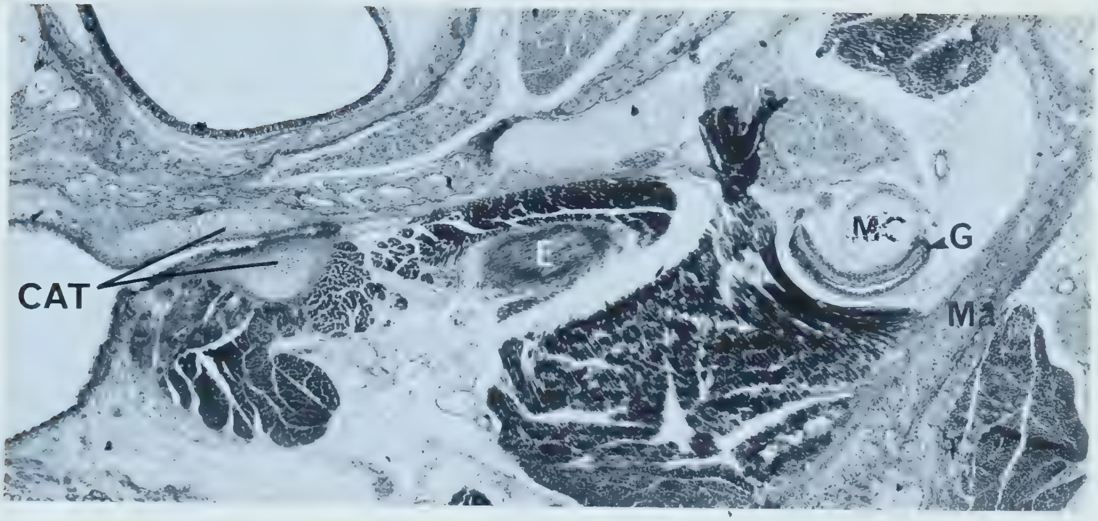
FIG. VII-9 _H. semispinosus_ MPIH 1964/45 (near-term fetus); s. 1312, left side; Azan; x 36.

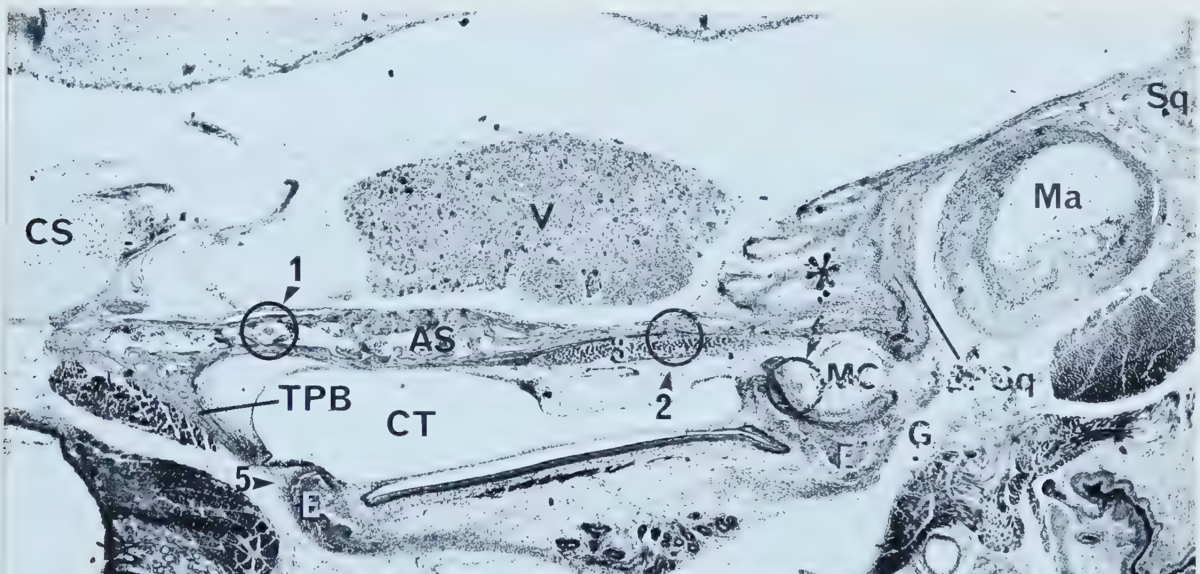
Section through cartilage of the auditory tube. There is no sign of an entotympanic element.

FIG. VII-10 _H. semispinosus_ MPIH 1964/45 (near-term fetus); s. 1332, cross-section, left side; Azan; x 36.

Section through anterior end of presumptive tympanic cavity. The greatly-thickened body of the alisphenoid (asterisk) represents the developing tympanic process of the alisphenoid, although this is not particularly evident because of the transverse plane of sectioning. Since the nerves of the pterygoid canal enter the substance of the alisphenoid even at this stage, the position of the tympanic aperture of the canal is no guide to the approximate location of the pterygoid element (which is fused to the sphenoid in any event).

1, nerves of the pterygoid canal; 2, lesser petrosal n.; 3, tensor veli palatini m.; 4, chorda tympani, 5, FMTC.


CAT
E
MC
G
Ma


Sq
Ma
CS
V
1
*
AS
MC
2
TPB
CT
G
5
E

716

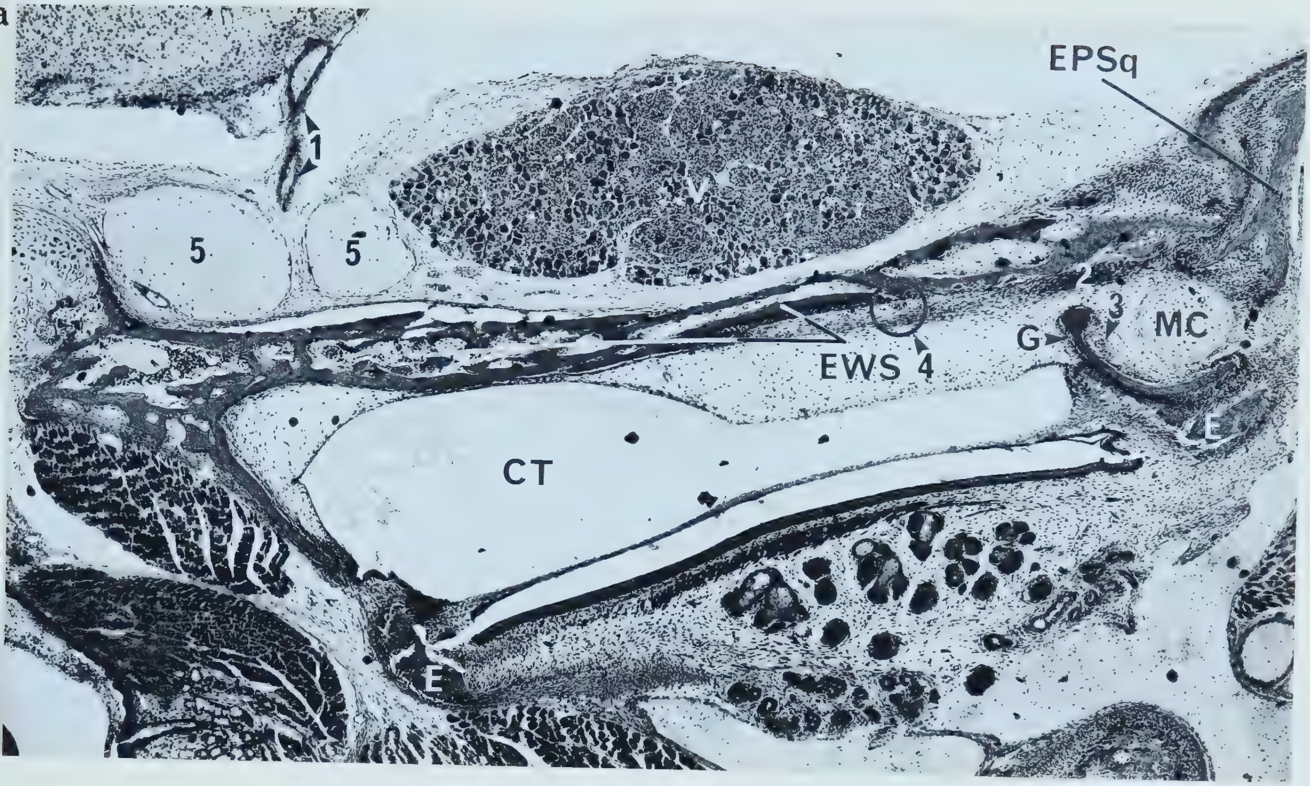
FIG. VII-11 _H. semispinosus_ MPIH 1964/45 (near-term fetus); s. 1352, cross-section, left side; Azan.

a. Section through tympanic process of basisphenoid; x 47.

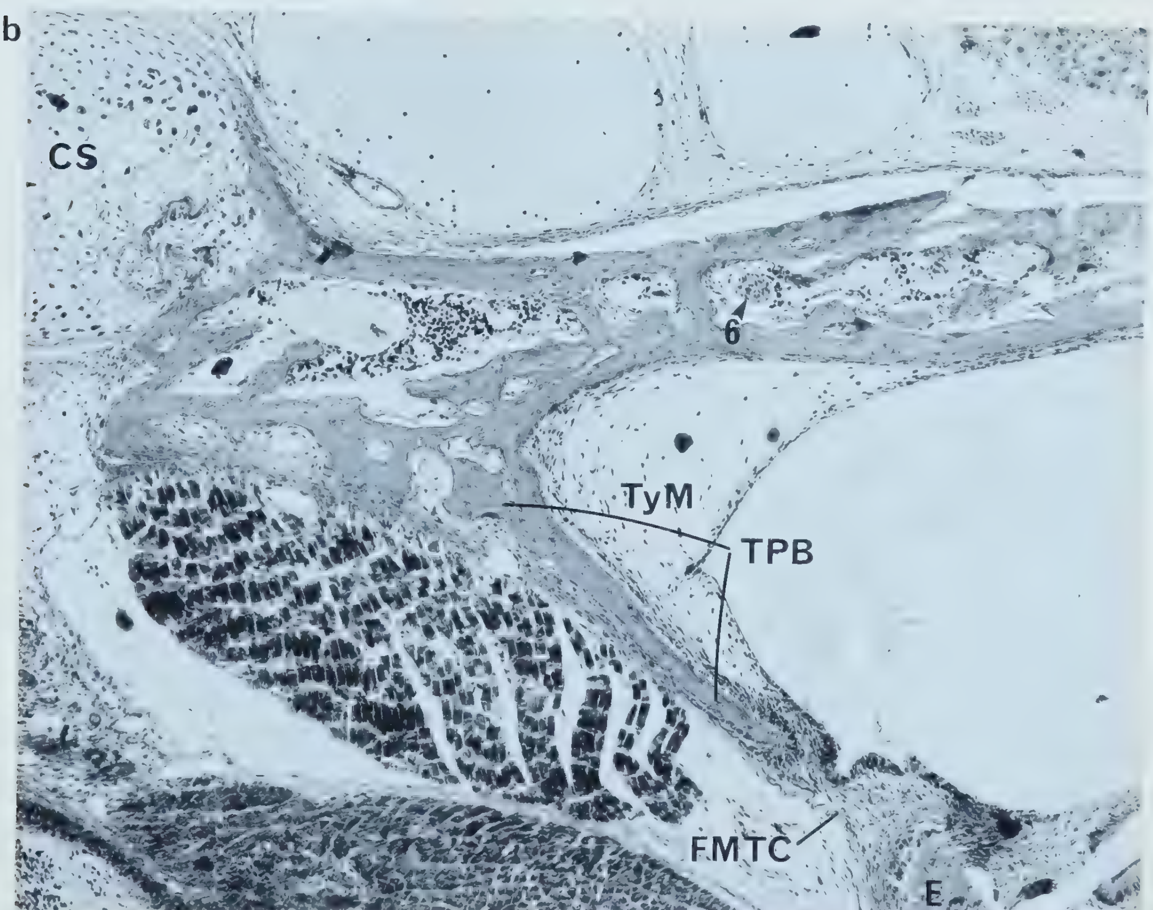
b. Enlargement of area around tympanic process of basisphenoid, showing relationship of latter to the FMTC. Note that the ventral end of the process is actively growing, as indicated by the presence of numerous osteoblasts. However, the relationship between the tympanic process of the basisphenoid and the ectotympanic is still athictic (and not semiphaneric, as in the adult stage); x 108.

1, promontorial a. (cerebral carotid a.) joining circulus arteriosus; 2, tensor veli palatini; 3, chorda tympani; 4, lesser petrosal n.; 5, cavernous sinus; 6, nerves of the pterygoid canal.

a



b



718

FIG. VII-12 H. semispinosus MPIH 1964/45 (near-term fetus); s. 1452, cross-section, Azan; x 31.

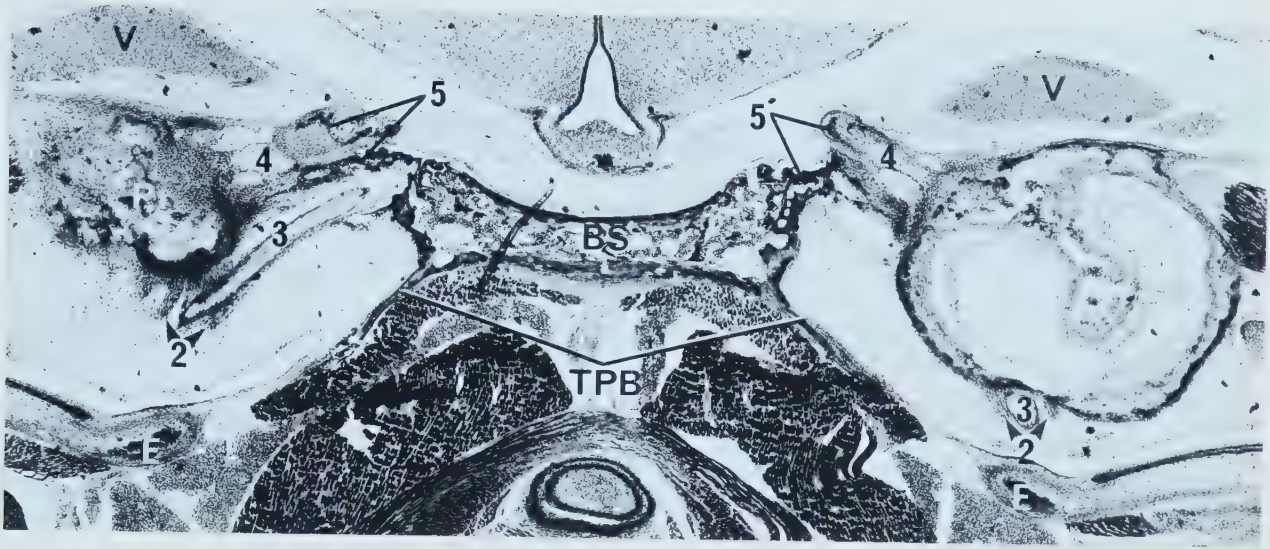
Processes of the basisphenoid precociously develop around the degenerating alicochlear commissures, thus defining the definitive anterior carotid foramen.

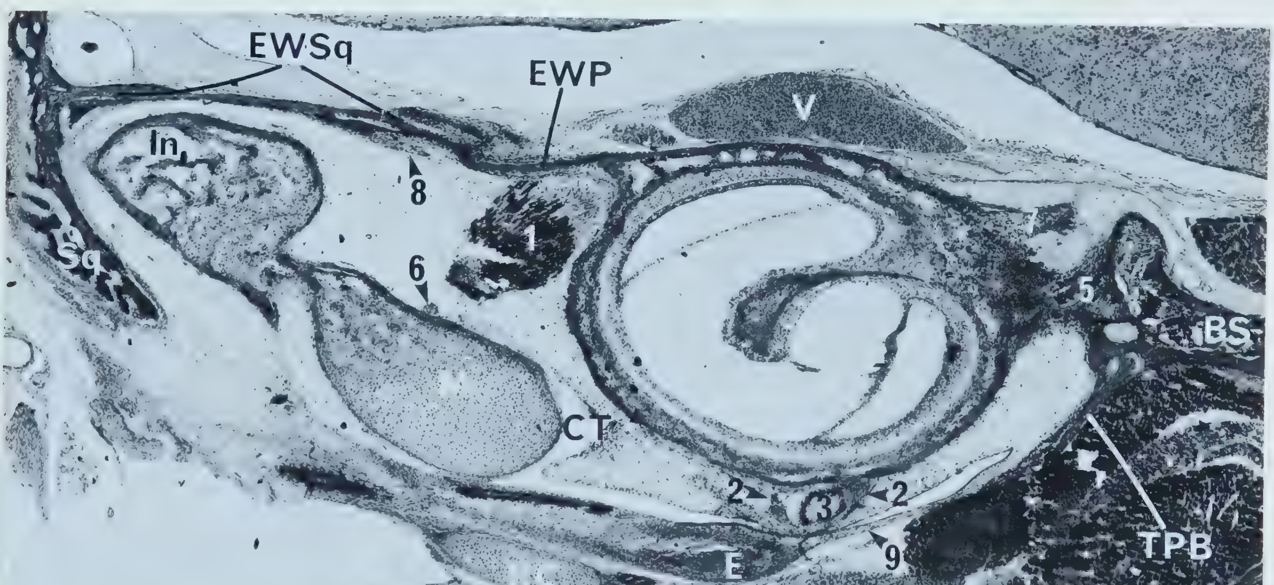
1, tensor tympani m.; 2, internal carotid n.; 3, promontorial a.; 4, alicochlear commissure (degenerating); 5, processes of basisphenoid surrounding commissures; 6, chorda tympani; 7, anterior basicapsular commissure; 8, lesser petrosal n.; 9, FMTC.

FIG. VII-13 H. semispinosus MPIH 1964/45 (near-term fetus); s. 1462, cross-section, right side; Azan; x 36.

The basisphenoid also sends out processes to enclose the degenerating anterior basicapsular commissure (7), thus completing the rear wall of the anterior carotid foramen.

For key to numbered structures, see fig. VII-12.


V
5
4
3
2
BS
TPB
E
V
5
4
3
2
E

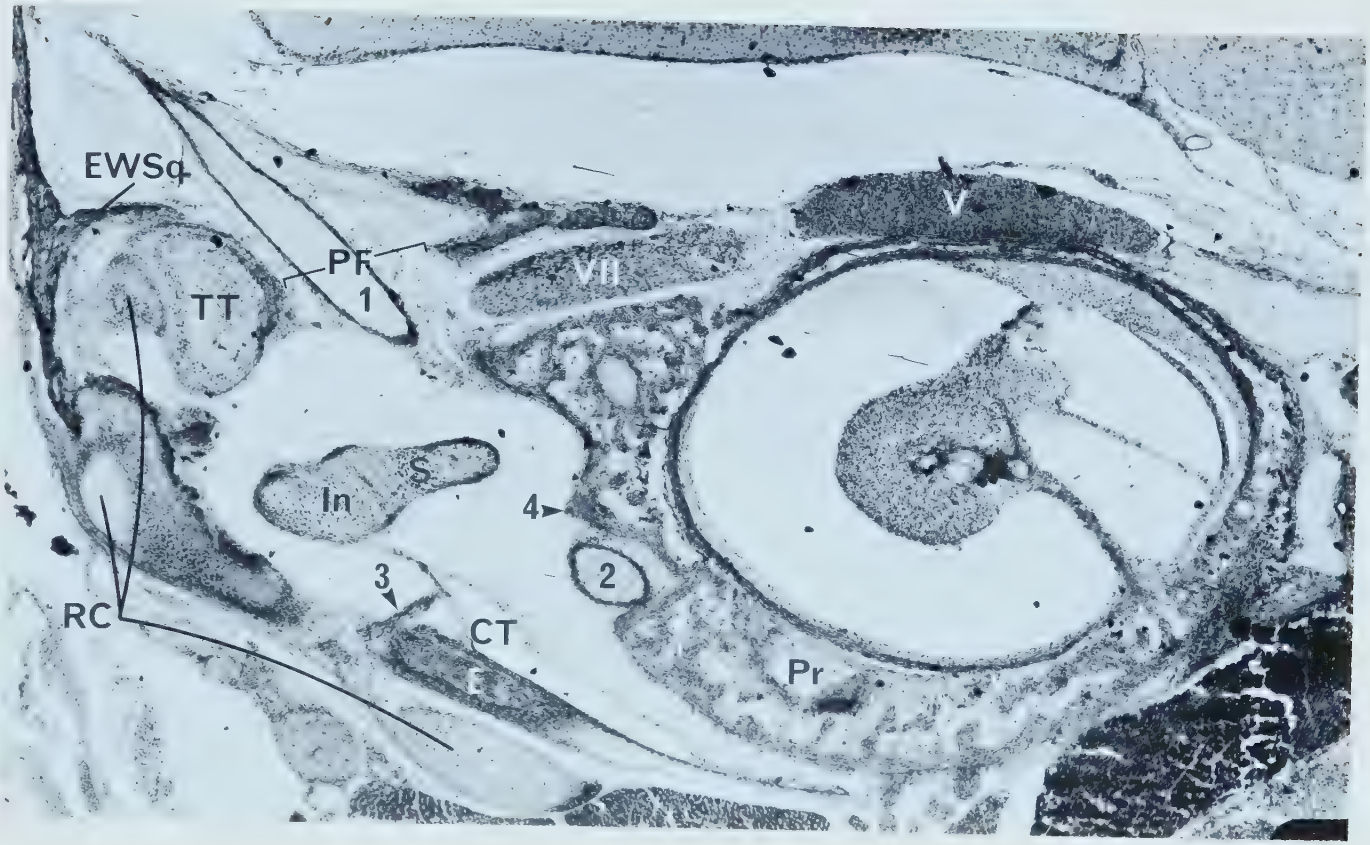

EWSq
EWP
V
In
8
Sq
6
5
BS
CT
2
3
2
9
E
TPB

720

FIG. VII-14 *H. semispinosus* MPIH 1964/45 (near-term fetus); s. 1502, cross-section, right side; Azan; x 42.

The piriform fenestra extends to the posterolateral end of the dorsal wall, due to the insignificant development of the tegmen tympani. This section passes through the terminal part of the fenestra, which serves as the aperture through which the ramus superior of the stapedial a. leaves the tympanic cavity. The foramen faciale opens adjacent to the foramen for the ramus superior, as in the adult (see fig. VII-2).

1, ramus superior of stapedial a. passing through piriform fenestra; 2, stapedial a. (proximal portion); 3, chorda tympani; 4, tympanic n.; 5, insertion of stapedius m. on stapes.



EWSq
PF
1
TT
VII
V
S
In
4
2
3
CT
E
Pr
RC

722

FIG. VII-15 *H. semispinosus* MPIH 1964/45 (near-term fetus); s. 1524, cross-section, right side; Azan; x 37.

Proximal part of stapedial a. passing through obturator foramen of stapes. The asterisk indicates the start of the lateral section of the CTPP.

For key to numbered structures, see fig. VII-14.


BBS
V
Pr
CT
S
2
S
5
4
VII
RC
CrP
Sq

724

FIG. VII-16 _H. semispinosus_ MPIH 1964/45 (near-term fetus); x. 1534, cross-section, right side; Azan; x 44.

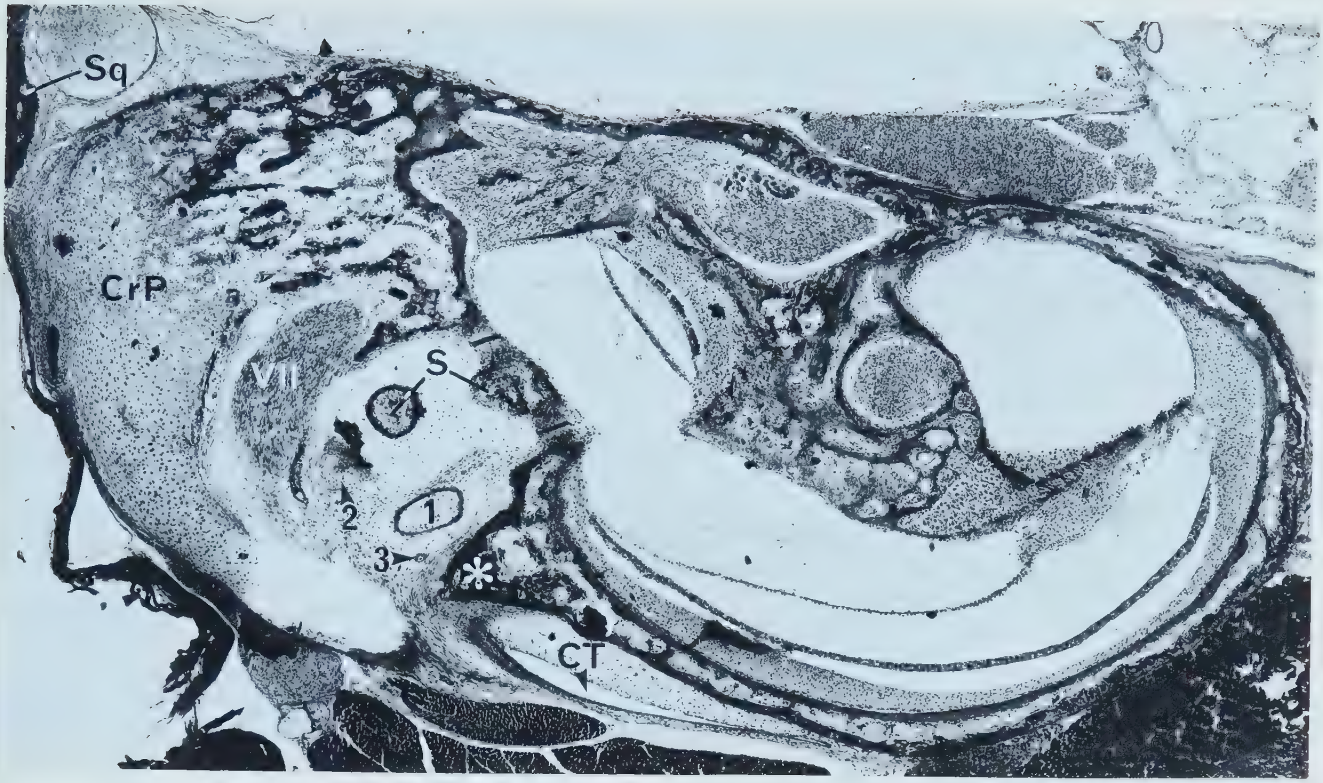
The proximal part of the stapedial a. has released the ramus posterior (1) beneath the stapes. The asterisk indicates the lateral section of the CTPP.

1, ramus posterior of the stapedial a.; 2, stapedius tendon; 3, tympanic n.

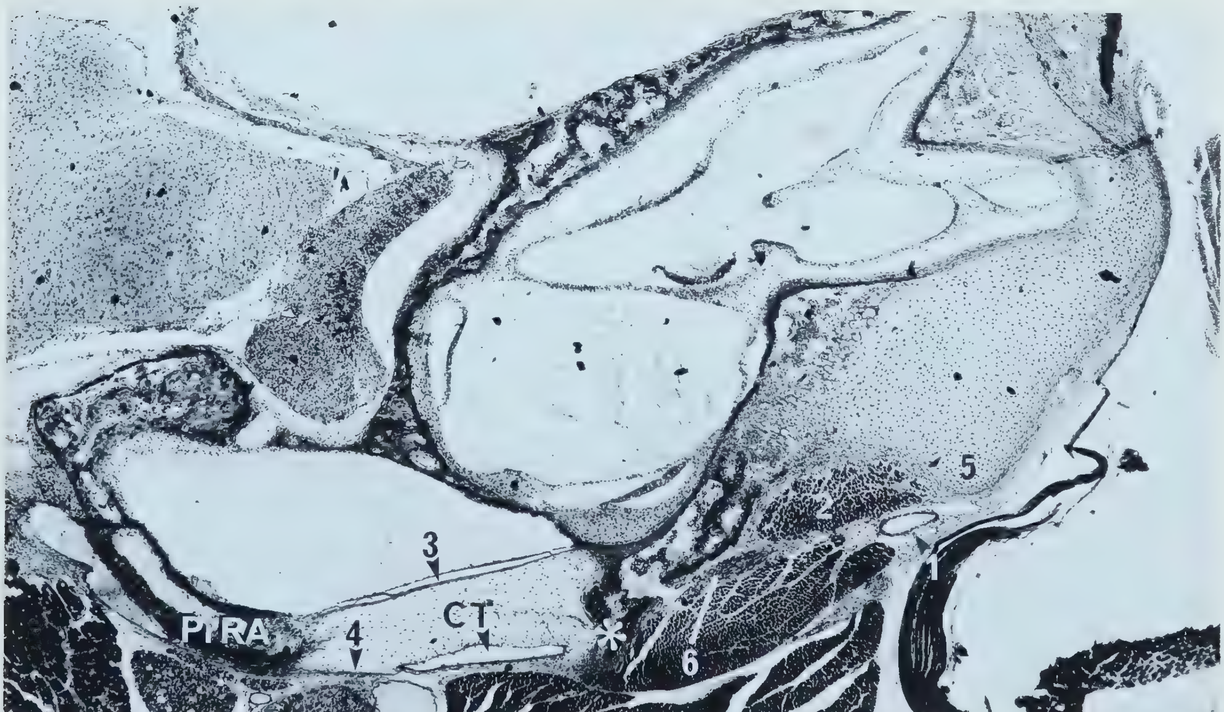
FIG. VII-17 _H. semispinosus_ MPIH 1964/45 (near-term fetus); s. 1574, cross-section, right side (sides rev.); Azan; x 42.

The lateral section of the CTPP continues posteriorly along the underside of the auditory capsule (asterisk).

1, ramus posterior of the stapedial a.; 2, stapedius m.; 3, secondary tympanic membrane; 4, FMTC; 5, posterior continuation of crista parotica; 6, ramus auricularis vagi.



Sq
CrP
VII
S
2
1
3
*
CT



5
2
1
3
PtRA
4
CT
*
6

726

FIG. VII-18 H. semispinosus MPIH 1964/45 (near-term fetus).

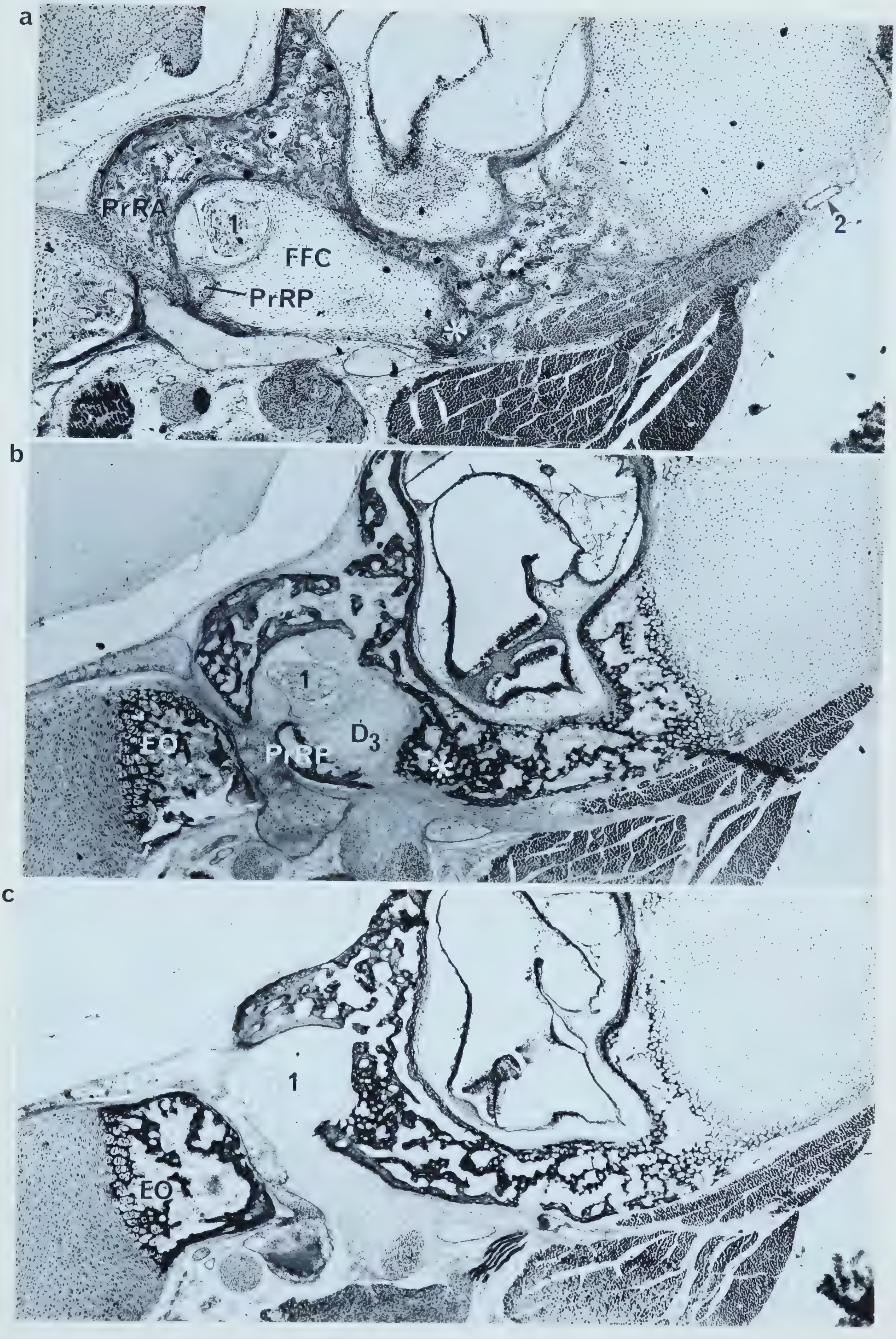
a. s. 1612, cross-section, right side (sides rev.); Azan; x 44.

b. s. 1630, cross-section, right side (sides rev.); Klüver-Barrera; x 44.

c. s. 1640, cross-section, right side (sides rev.); Klüver-Barrera; x 44.

The processus recessus posterior serves as the medial section of the CTPP, and meets the lateral section (asterisks) beneath the terminal part of D_3. The CTPP is quite insignificant in size even at this stage of development.

1, perilymphatic duct; 2, ramus posterior of the stapedial a.; 3, auricular ramus of the vagus travelling with tympanic n.


a
PrRA
1
FFC
PrRP
2
b
1
EO
D3
PrRP
c
1
EO

728

FIG. VII-19 _S. setosus_ MPIH 1964/93 (fetus); s. 1660, cross-section, left side; Klüver-Barrera; x 30.

The posterior part of the pterygoid is very well-developed in _S. setosus_. Although it is fused to the sphenoid by this stage, bone derived from the pterygoid is probably represented in this section (3). This section passes through the area where the tympanic processes of the basisphenoid and alisphenoid adjoin (anteromedial angle of tympanic cavity). The cartilage of the tube is present above the lumen of the auditory tube, but it is in young cartilage and has taken up little stain.

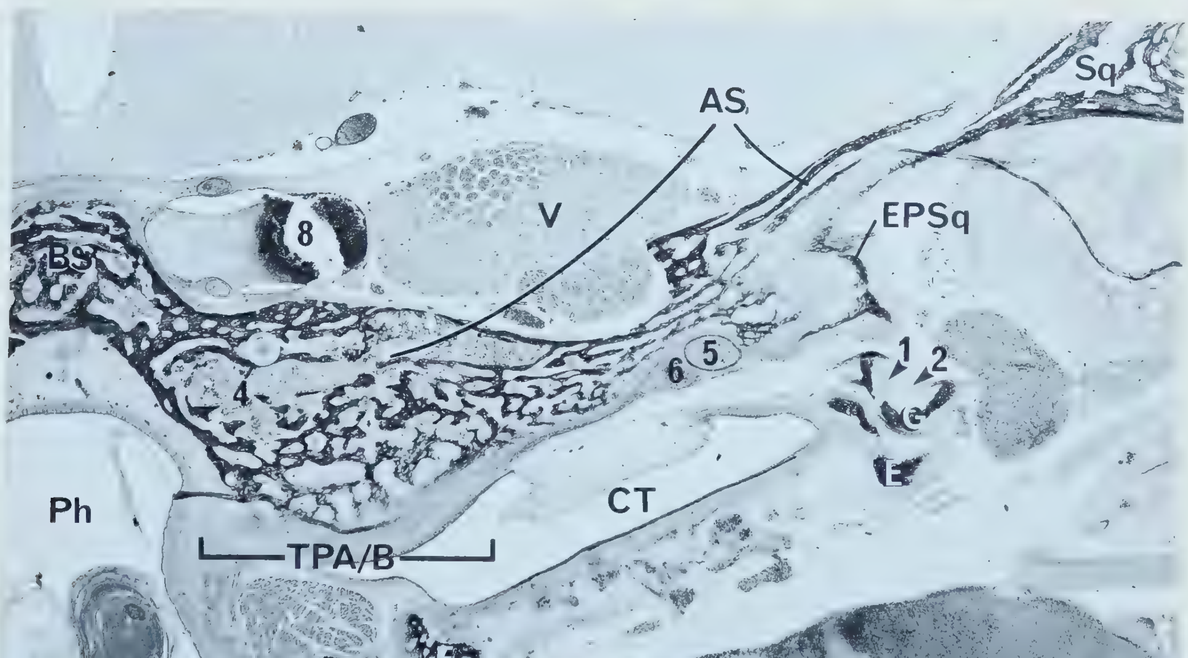
1, chorda tympani; 2, Meckel's cartilage (degenerating); 3, ?pterygoid; 4, nerves of the pterygoid canal; 5, ramus inferior of the stapedial a; 6, vein; 7, lesser petrosal n.; 8, cavernous sinus; 9, lumen of auditory tube.

FIG. VII-20 _S. setosus_ MPIH 1964/93 (fetus); s. 1680, cross-section, left side; Klüver-Barrera; x 30.

The tympanic processes of the basisphenoid and alisphenoid meet at the anteromedial angle of the presumptive tympanic cavity, and are thus difficult to separate in transverse sections of this region.

For key to numbered structures, see fig. VII-19.

AS
Sq
BS
8
V
V3
3
4
5
6
7
1
2
G
Ph
TPA
CT
E
9
E



AS
Sq
BS
8
V
EPSq
5
6
4
1
2
G
E
Ph
CT
TPA/B
E

730

FIG. VII-21 *S. setosus* MPIH 1964/93 (fetus); s. 1690, cross-section, left side; Klüver-Barrera; x 30.

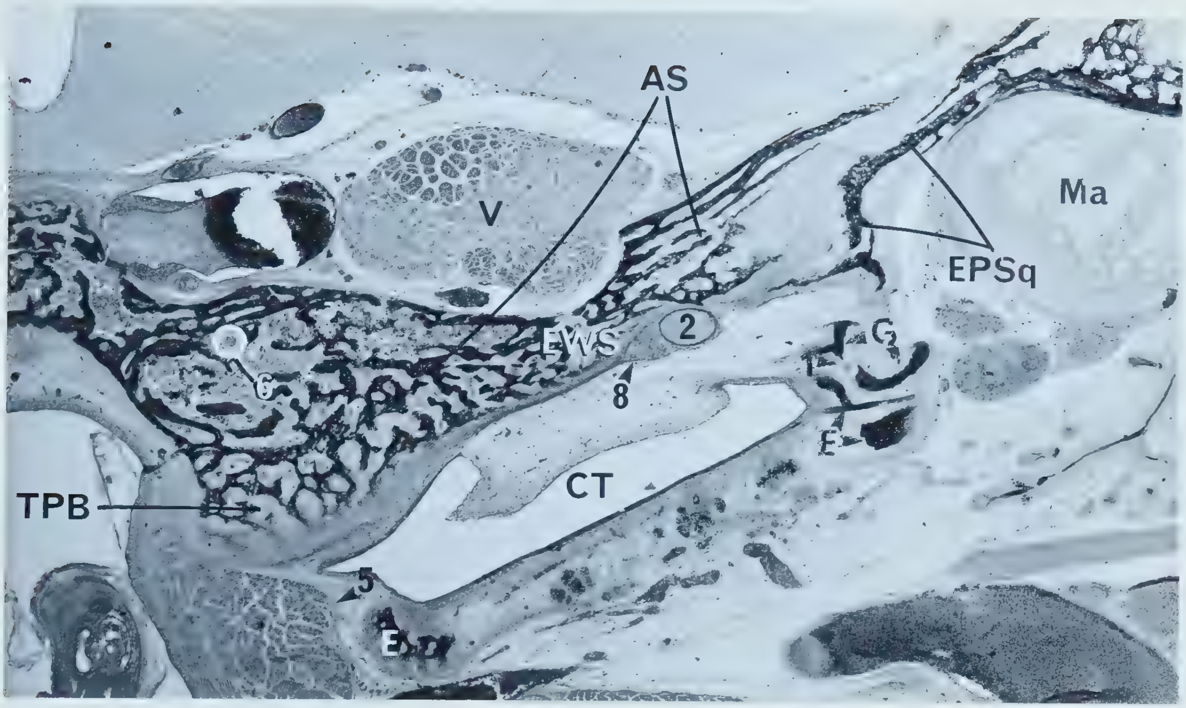
As in the two preceding figures, the thickened portion of the alisphenoid represents the developing tympanic process of the alisphenoid. In the adult stage, the process completely surrounds the ramus inferior of the stapedial a. at its point of exit from the tympanic cavity.

For key to numbered structures, see fig. VII-22.

FIG. VII-22 *S. setosus* MPIH 1964/93 (fetus); x. 1770, cross-section, left side; Klüver-Barrera; x 30.

The posterior part of the piriform fenestra is largely closed over in this specimen, due to the development of the epitympanic wings of the petrosal and squamosal (cf. fig. VII-6).

1, chorda tympani; 2, ramus inferior of the stapedial a.; 3, internal carotid n.; 4, promontorial a.; 5, FMTC; 6, nerves of the pterygoid canal; 7, petrosquamous sinus in postglenoid foramen; 8, lesser petrosal n.; 9, greater petrosal n.; 10, tensor tympani m.



AS
V
Ma
EPSq
EWS
2
G
6
8
E
CT
TPB
5
E

EWSq
V
7
EWP
8
3
9
2
10
Pr
Sq
In
1
3
3
4
TPB
M
CT
5
E
RC

732

FIG. VII-23 S. setosus MPIH 1964/93 (fetus); x. 1800, cross-section, left side; Klüver-Barrera; x 30.

Section through middle of presumptive tympanic cavity.

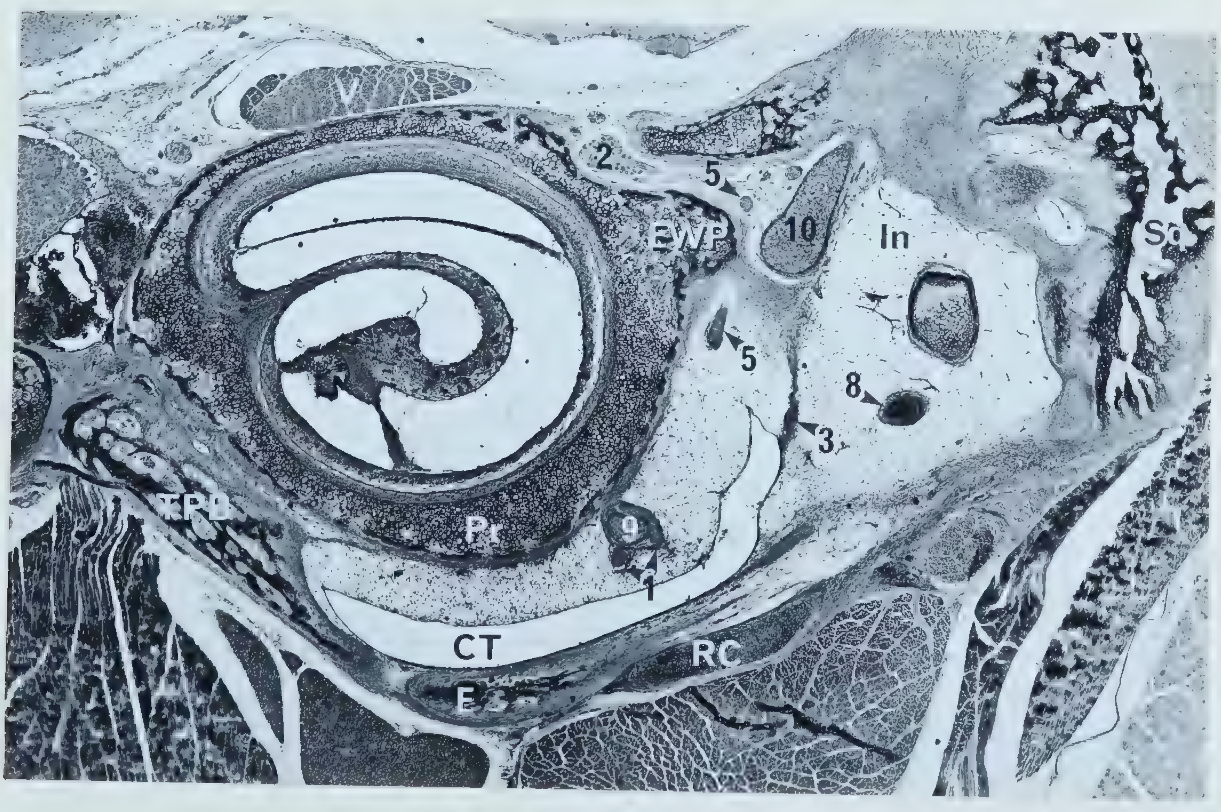
1, internal carotid n.; 2, geniculate ganglion; 3, chorda tympani; 4, greater petrosal n. arising from geniculate ganglion; 5, tympanic plexus and tympanic n.; 6, ramus inferior of the stapedial a.; 7, ramus superior of the stapedial a.; 8, ?element of Spence; 9, promontorial a.; 10, proximal stapedial a. dividing into ramus superior and ramus inferior.

FIG. VII-24 S. setosus MPIH 1964/93 (fetus); s. 1830, cross-section, left side; Klüver-Barrera; x 30.

Section through middle of presumptive tympanic cavity.

For key to numbered structures, see fig. VII-23.


7
EwSq
4
EWP
ER
In
Sq
5
6
3
M
Pr
1
9
1
TPB
CT
E
RC


2
5
EWP
10
In
Sq
5
8
3
TPB
Pr
9
1
CT
RC
E

734

FIG. VII-25 S. setosus MPIH 1964/93 (fetus).

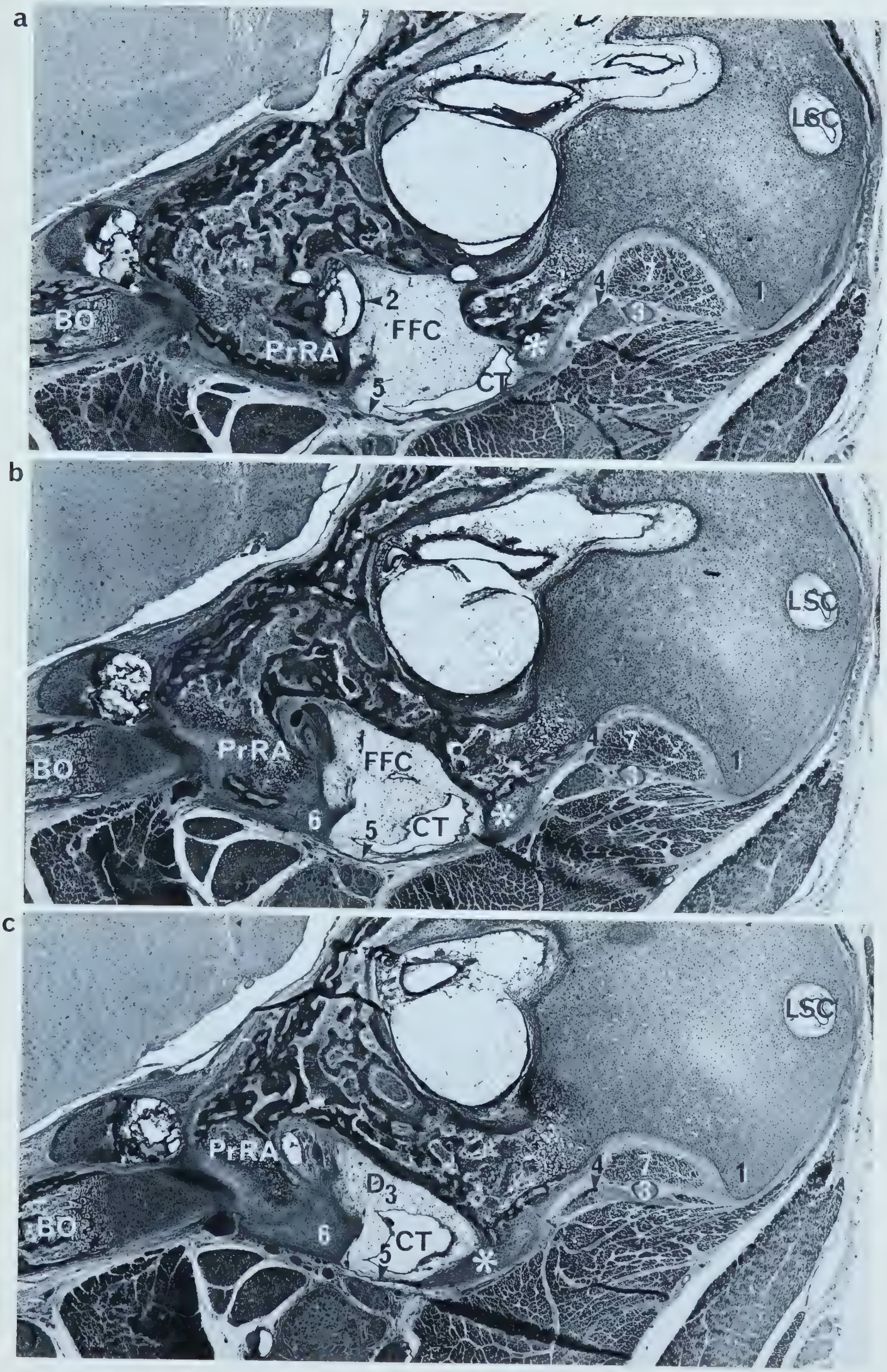
a. s. 1970, cross-section, right side (sides rev.); Klüver-Barrera; x 30.

b. s. 1980, cross-section, right side (sides rev.); Klüver-Barrera; x 30.

c. s. 1990, cross-section, right side (sides rev.); Klüver-Barrera; x 30.

The processus recessus posterior (6) is in young cartilage and is not distinctly stained. The medial section of the CTPP eventually develops from this processus (cf. fig. VII-18). The lateral section of the CTPP (asterisks) is more distinct, but it is small.

1, posterior continuation of crista parotica; 2, secondary tympanic membrane; 3, ramus posterior of the stapedial a.; 4, ramus auricularis vagi; 5, FMTC; 6, processus recessus posterior; 7, stapedius m.


a
LSC
2
4
7
1
3
BO
FFC
PrRA
CT
5
*
b
LSC
4
7
1
3
PrRA
FFC
BO
6
5
CT
*
c
LSC
PrRA
4
7
1
3
D3
BO
6
CT
5
*

736

FIG. VII-26 _M. dobsoni_ MPIH 1964/103 (fetus); s. 990, cross-section, left side; Gabe; x 63.

The posterior part of the pterygoid bone (4) has not yet fused to the undersurface of the basisphenoid. Note that its site of termination is directly above the cartilage of the tube (cf. fig. VII-27).

1, ramus inferior of the stapedial a.; 2, chorda tympani; 3, nerves of the pterygoid canal; 4, pterygoid bone; 5, otic ganglion; 6, lesser petrosal n.

FIG. VII-27 _M. dobsoni_ MPIH 1964/103 (fetus); s. 1010, cross-section, left side; Gabe; x 63.

Section through anterior end of cavum tympani.

For key to numbered structures, see fig. VII-26.

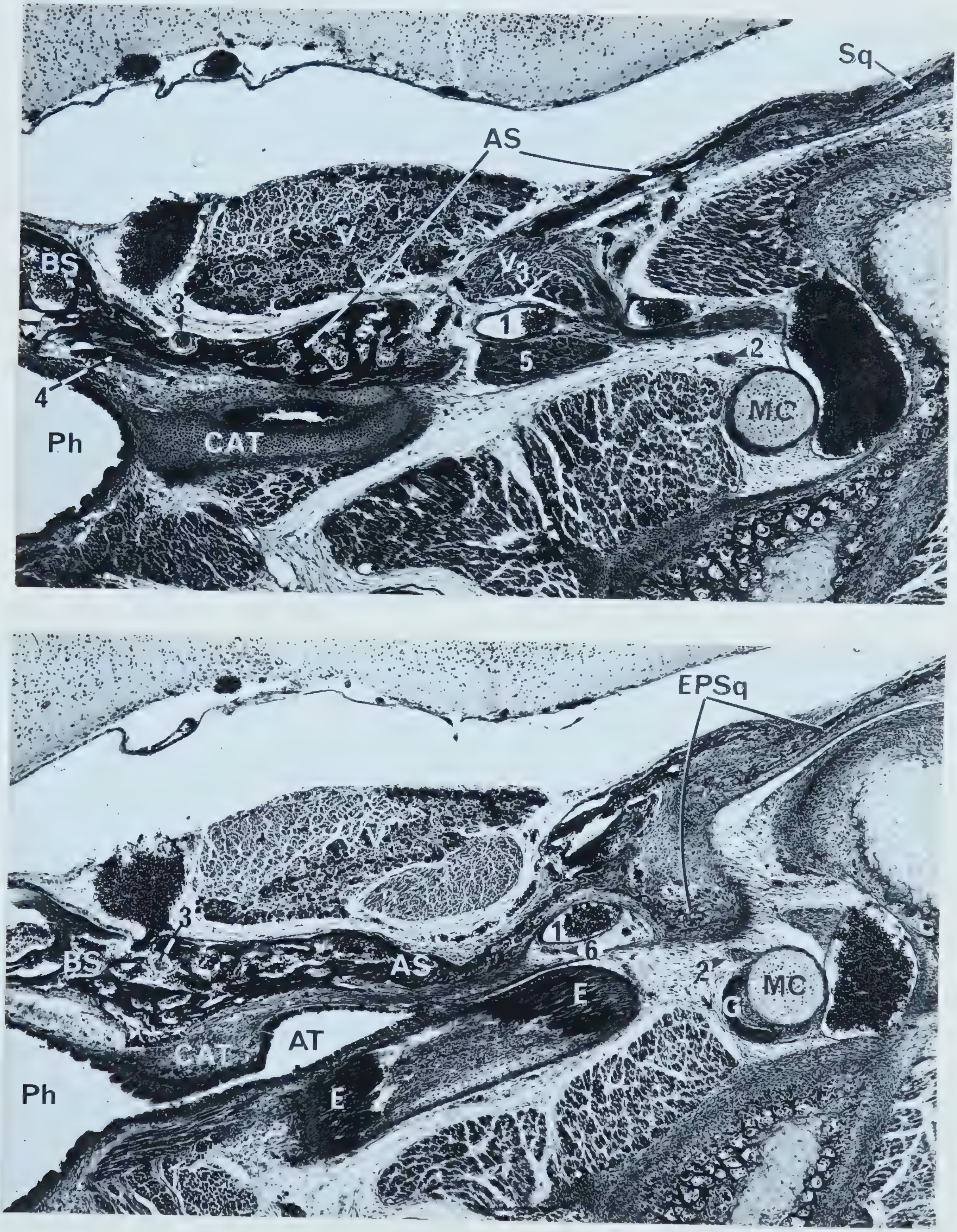

Sq
AS
V
BS
V3
3
1
2
5
4
MC
Ph
CAT
EPSq
V
3
1
BS
6
AS
2
MC
E
G
CAT
AT
Ph
E

FIG. VII-28 M. dobsoni MPIH 1964/103 (fetus); s. 1094, cross-section, left side; Klüver-Barrera; x 47.

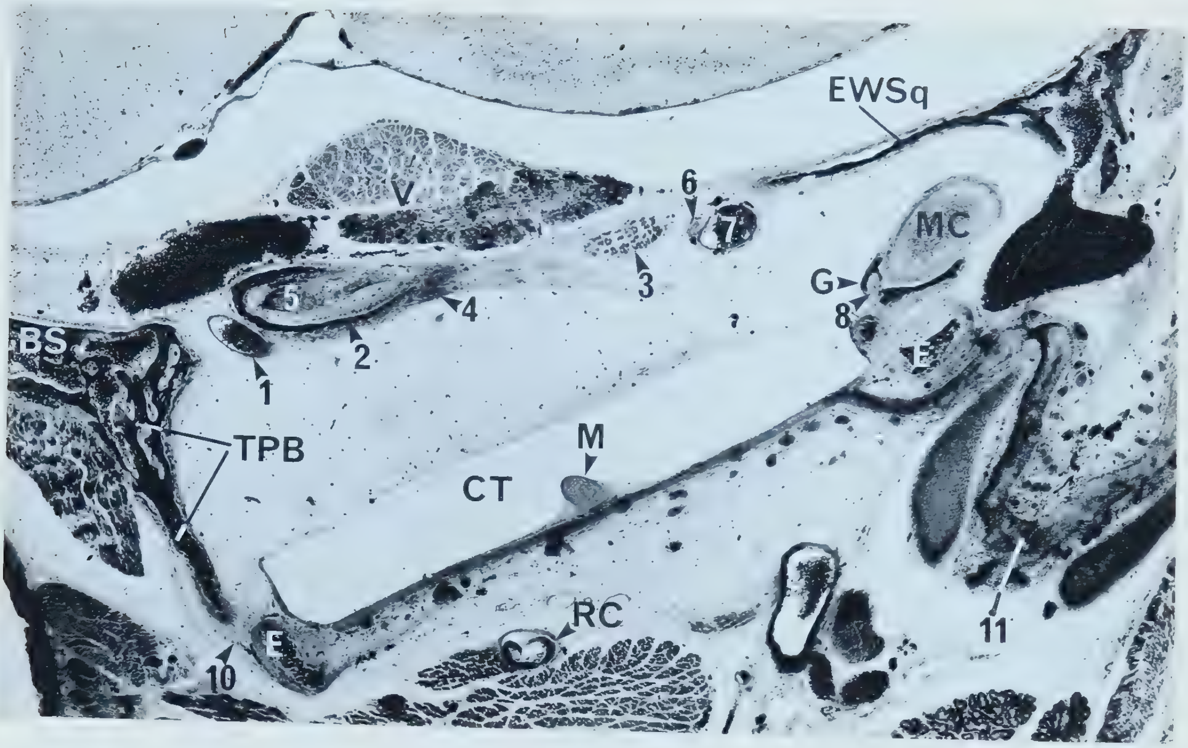
Section through anterior carotid foramen. A process of the basisphenoid has encircled the degenerating alicochlear commissure (2).

1, promontorial a.; 2, process of basisphenoid surrounding alicochlear commissure; 3, tensor tympani; 4, deep petrosal and greater petrosal nn.; 5, alicochlear commissure; 6, lesser petrosal n.; 7, ramus inferior of the stapedial a.; 8, chorda tympani; 9, ramus superior of the stapedial a.; 10, FMTC; 11, external acoustic meatus.

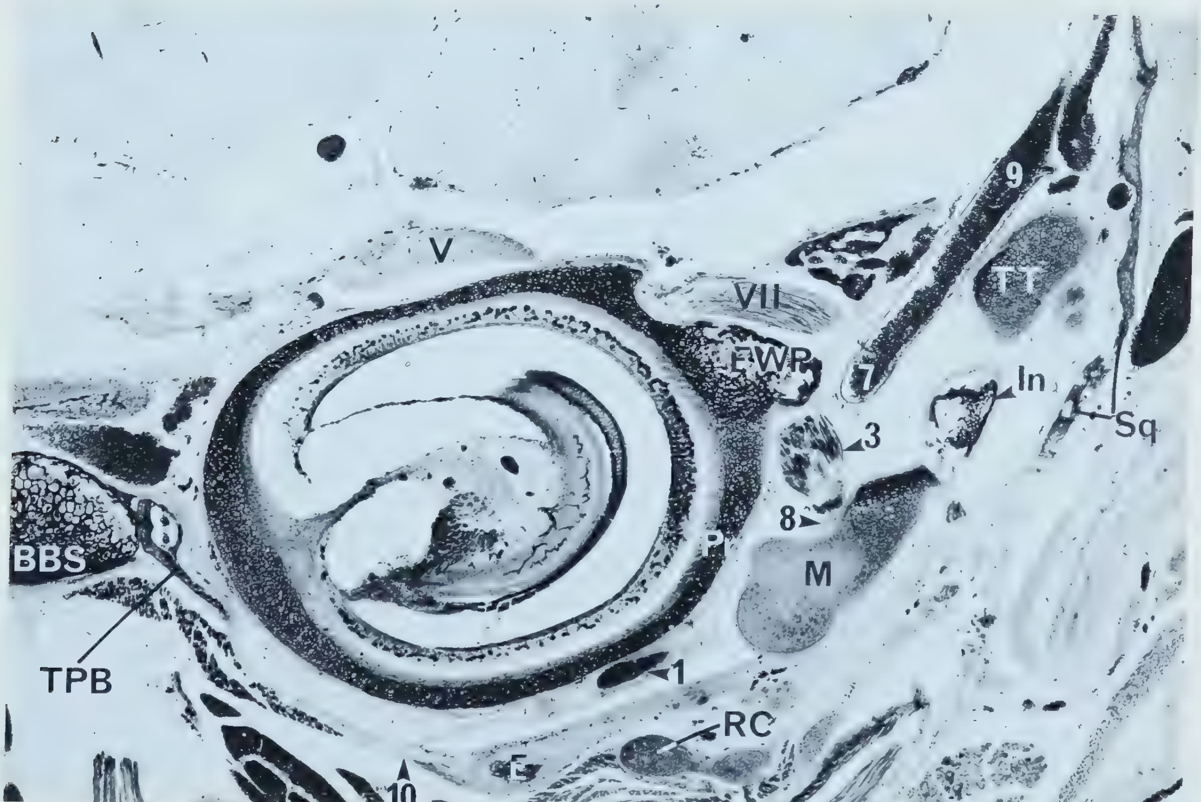
FIG. VII-29 M. dobsoni MPIH 1964/103 (fetus); s. 1164, cross-section, left side; Klüver-Barrera; x 41.

Section through anterior end of tegmen tympani. In the adult, the foramen faciale is separate from the foramen for the ramus superior (cf. figs. VII-1, VII-14).

For key to numbered structures, see fig. VII-28.



EWSq
V
6
7
MC
3
G
5
4
8
BS
2
E
1
TPB
M
CT
RC
E
11
10



9
V
VII
TT
EWP
7
In
3
Sq
8
BBS
P
M
TPB
1
RC
E
10

740

FIG. VII-30 _M. dobsoni_ MPIH 1964/103 (fetus).

a. s. 1254, cross-section, left side; Klüver-Barrera; x 56.

b. s. 1264, cross-section, left side; Klüver-Barrera; x 56.

c. s. 1264, cross-section, right side (sides rev.); Klüver-Barrera; x 56.

d. s. 1274, cross-section, right side (sides rev.); Klüver-Barrera; x 56.

Series of sections through the caudal tympanic process of the petrosal. The caudal tympanic process of Oryzorictinae is relatively larger than in Tenrecinae (see fig. VII-3) and completely covers the apertura fossulae fenestrae cochleae. Cartilage 'islands' may still be seen in the anterior rim of the process (asterisks). The small eminence on the ventral surface of the promontory (1) may represent a tiny rostral tympanic process of the petrosal.

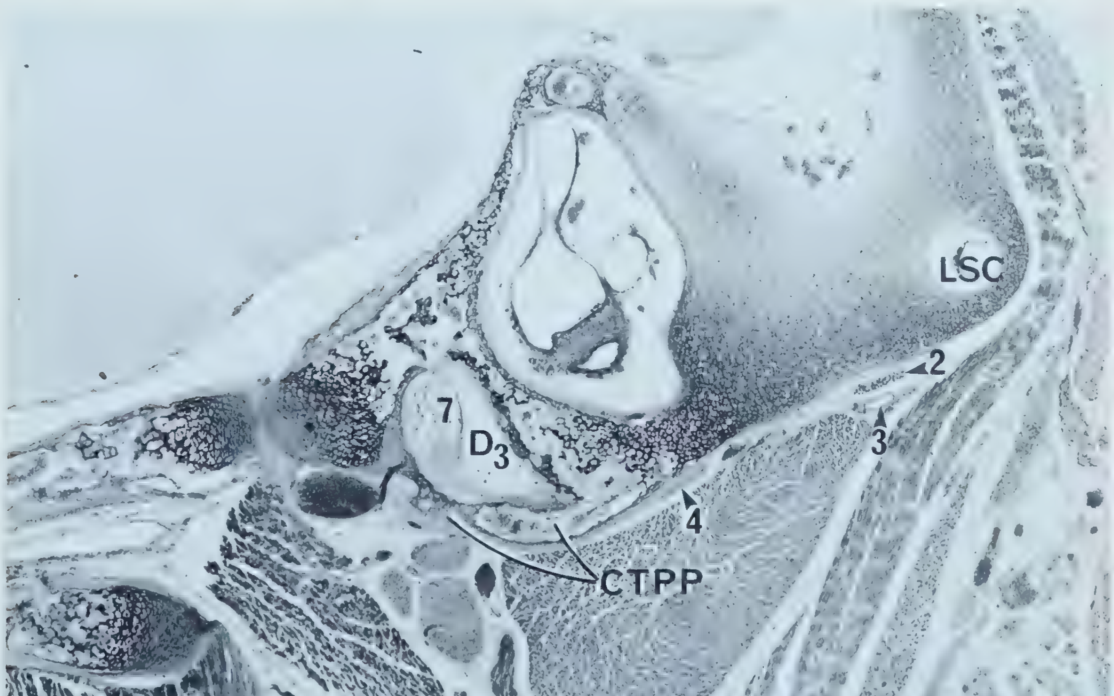
1, ?rostral tympanic process of the petrosal; 2, stapedius m.; 3, ramus posterior of the stapedial a.; 4, ramus auricularis of the vagus n. (?with tympanic n.); 5, posterior continuation of crista parotica; 6, secondary tympanic membrane; 7, perilymphatic duct.


a
LSC
5
2
4
3
CT
1
CTPP
b
LSC
5
2
FFC
6
4
3
CT
*
CTPP

742

c

d

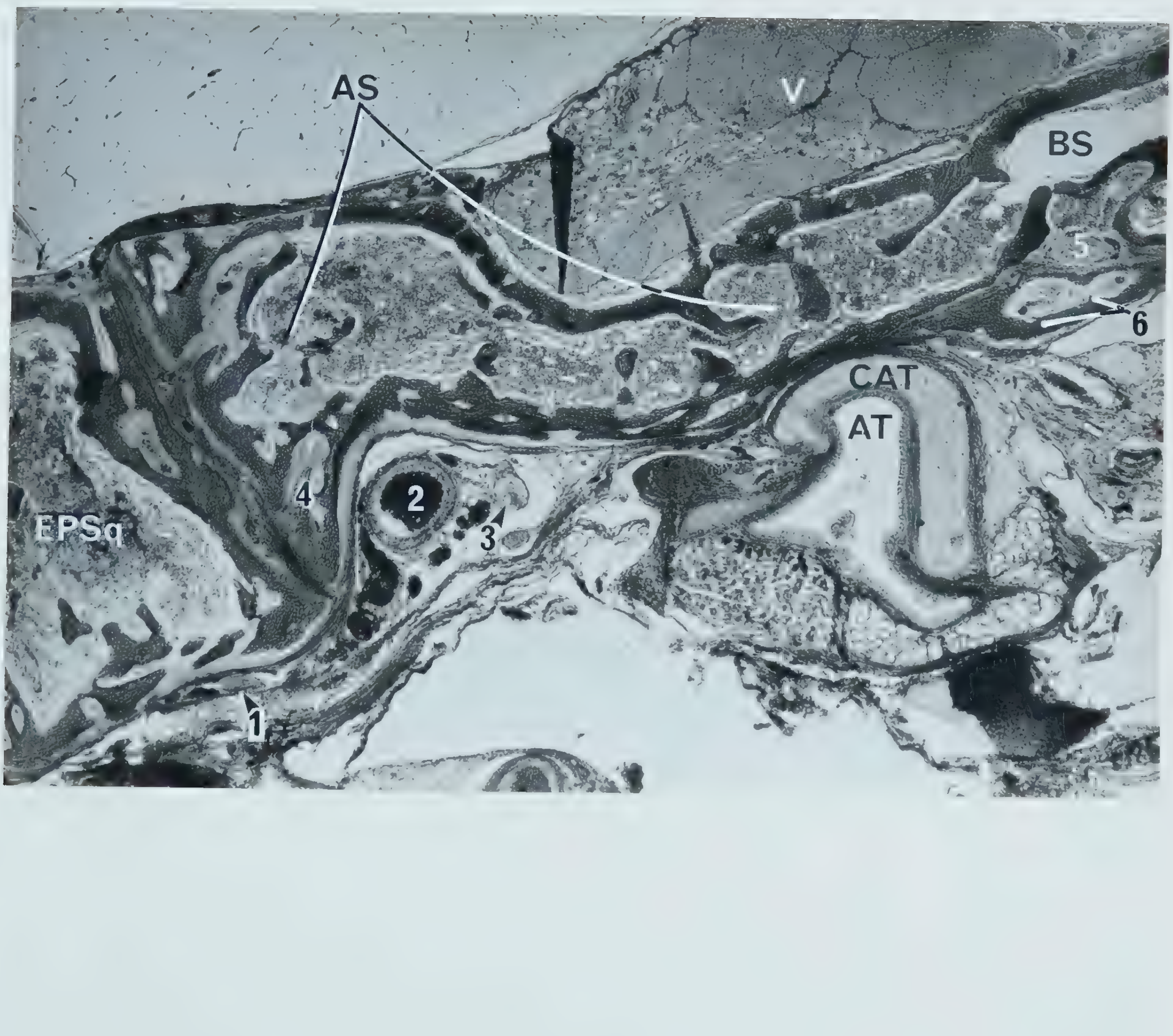


743

FIG. VII-31 _Solenodon_ sp. MPIH 6863 (juvenile); s. 1119, cross-section, right side; Azan; x 25.

Section through auditory tube, in advance of cavum tympani. The only outgrowth on the basisphenoid which conforms to McDOWELL's tympanic process of the basisphenoid is the small ridge (6) adjacent to the tubal cartilage (cf. fig. VII-4). However, the relationship of this ridge to the pterygoid canal (5) suggests that the ridge may be pterygoidal rather than basisphenoidal in origin.

1, chorda tympani in groove on the entoglenoid process of the squamosal; 2, ramus inferior of the stapedial a.; 3, lesser petrosal n.; 4, lateral part of tympanic process of the alisphenoid; 5, nerves of the pterygoid canal; 6, ?tympanic process of basisphenoid.



AS
V
BS
5
6
CAT
AT
4
2
3
EPSq
1

45

FIG. VII-32 _Solenodon_ sp. MPIH 6863 (juvenile); s. 1318, cross-section, right side, Azan; x 16.

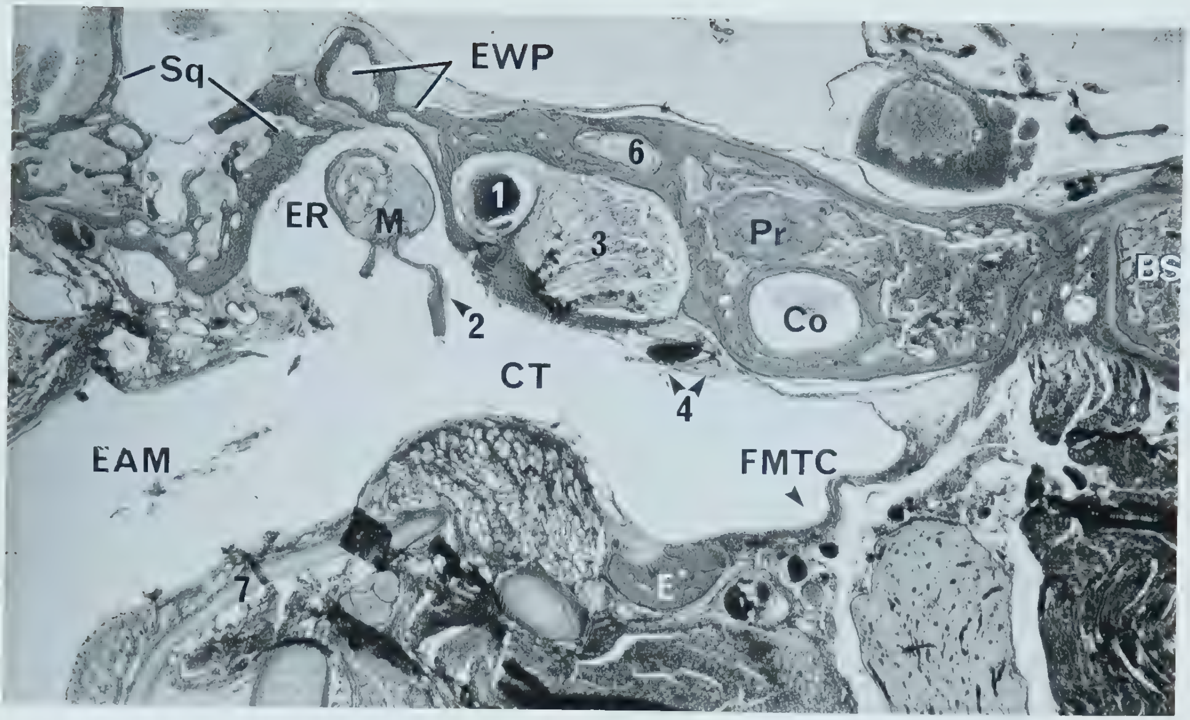
Section through anterior pole of promontory. Note thick fibrous membrane of the tympanic cavity.

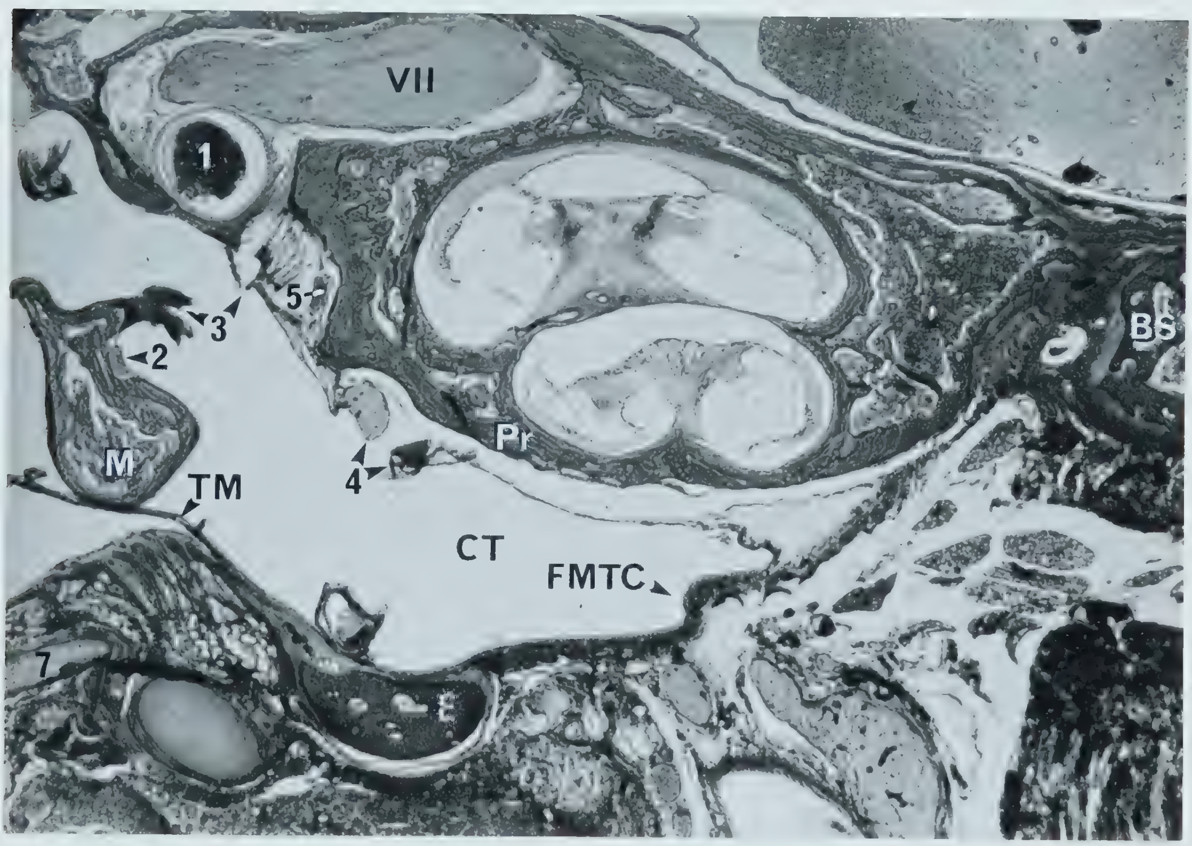
1, ramus inferior of the stapedial a.; 2, chorda tympani; 3, tensor tympani; 4, internal carotid n. and promontorial a.; 5, tympanic n.; 6, geniculate ganglion; 7, auricular cartilage.

FIG. VII-33 _Solenodon_ sp. MPIH 6863 (juvenile); s. 1354, cross-section, right side; Azan; x 25.

Section through middle of promontory.

For key to numbered structures, see fig. VII-32.


Sq
EWP
6
ER
M
1
3
Pr
BS
Co
2
CT
4
EAM
FMTC
7
E


VII
1
5
3
2
BS
M
TM
4
Pr
CT
FMTC
7
E

747

FIG. VII-34 Solenodon sp. MPIH 6863 (juvenile); s. 1418, cross-section, right side; Azan.

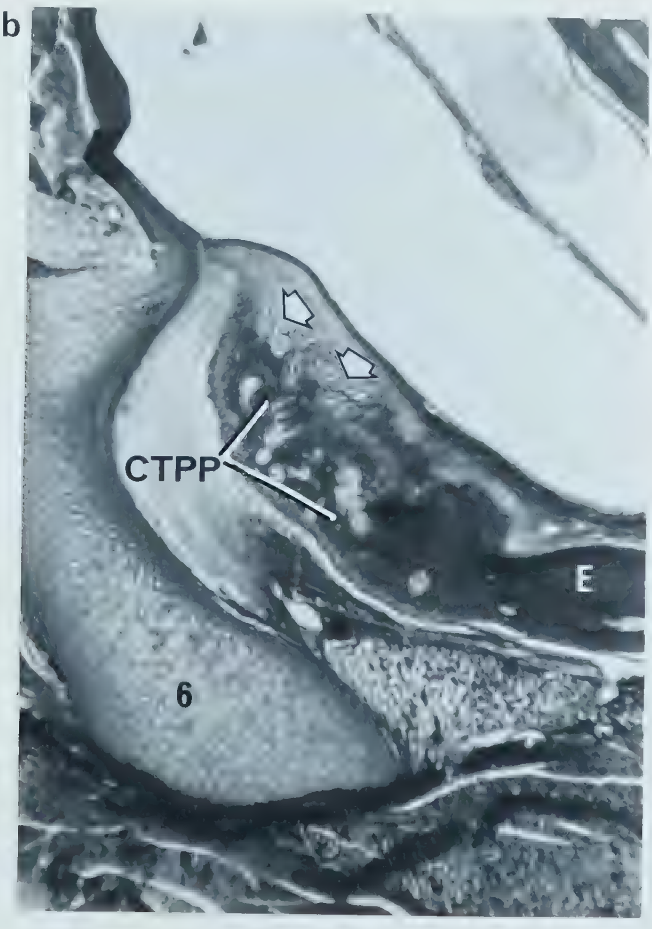
a. Section through posterior carotid foramen; x 16.

b. Enlargement of area of articulation between the posterior crus of the ectotympanic and the caudal tympanic process of the petrosal. Secondary cartilage can be detected at the place of articulation, indicating that the two bone territories are in the process of fusion (arrows); x 47.

1, tendon of stapedius m.; 2, internal carotid a.; 3, tympanic n.; 4, internal carotid n.; 5, ramus posterior of the stapedial a. (branch to pinna); 6, tympano-styloid cartilage; 7, FMTC; 8, cranial cervical ganglion.

a

b



749

FIG. VII-35 Solenodon sp. MPIH 6863 (juvenile); s. 1431, cross-section, left side; Azan; x 16.

Section through anterior end of caudal tympanic process of the petrosal. The ramus posterior of the stapedial a. cuts across this process as it leaves the tympanic cavity.

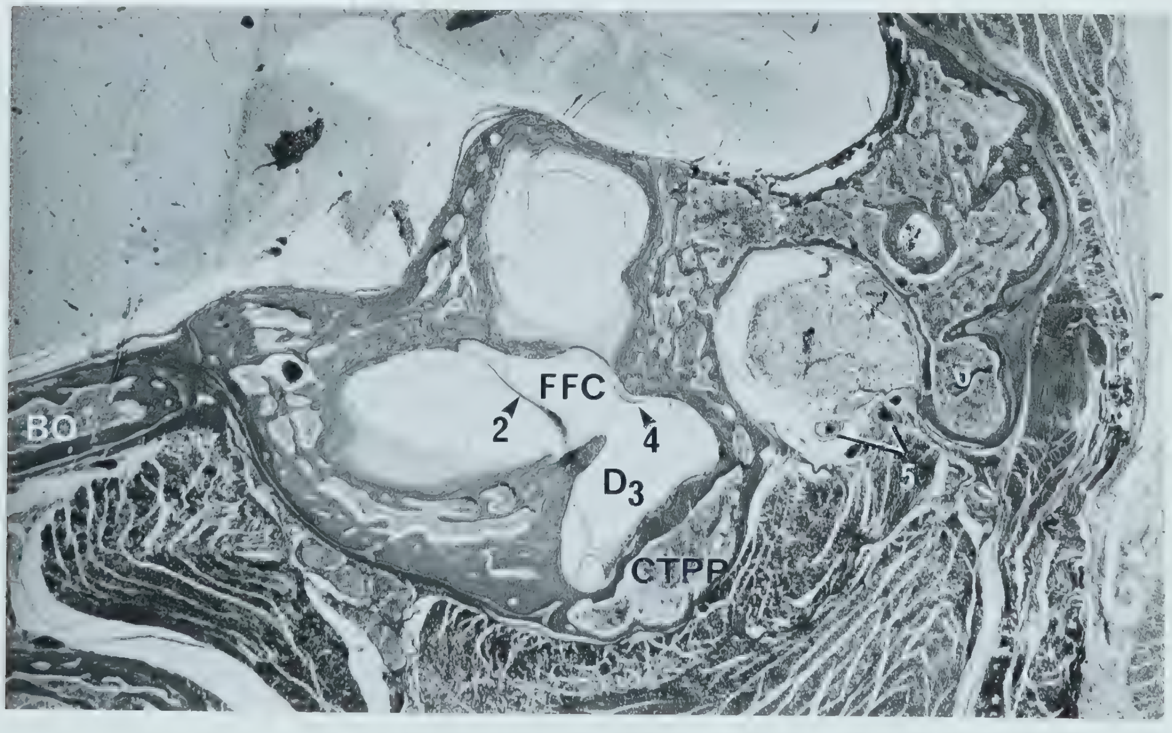
1, stapedius m.; 2, secondary tympanic membrane; 3, lateral semicircular canal; 4, tympanic n.; 5, ramus posterior of stapedial a.; 6, posterior continuation of crista parotica; 7, auricular ramus of the vagus.

FIG. VII-36 Solenodon sp. MPIH 6863 (juvenile); s. 1462, cross-section, left side; Azan; x 16.

As the ramus posterior leaves the tympanic cavity, it divides into branches. One or two small twigs continue posteriorly beneath the stapedius m. (this figure); another, large branch travels anteriorly towards the pinna (fig. VII-34a).

For key to numbered structures, see fig. VII-35.


BO
Pr
CT
4
CTPP
1
3
5
VII
6
Sq


BO
FFC
2
4
D3
CTPP
5
6

751

FIG. VIII-1 Relationships of the ectotympanic to other components of the ventral wall.

This figure schematically illustrates how the phaneric, semi-phaneric, and aphaneric conditions of the ectotympanic are controlled by the presence or relative intensity of three ontogenetic factors (growth, pneumatization, and soft-tissue influences). For explanation, see text (section 8.1.5.3).

1 - sutural tissues form

1^{1} - sutural tissues do not form, or form incompletely

2 - tympanic process grows significantly

2^{1} - tympanic process does not grow significantly

3 - degree of pneumatization is significant

3^{1} - degree of pneumatization is insignificant

Co, cochlea; Ec, ectotympanic; FM, fibrous membrane; TP, tympanic process.

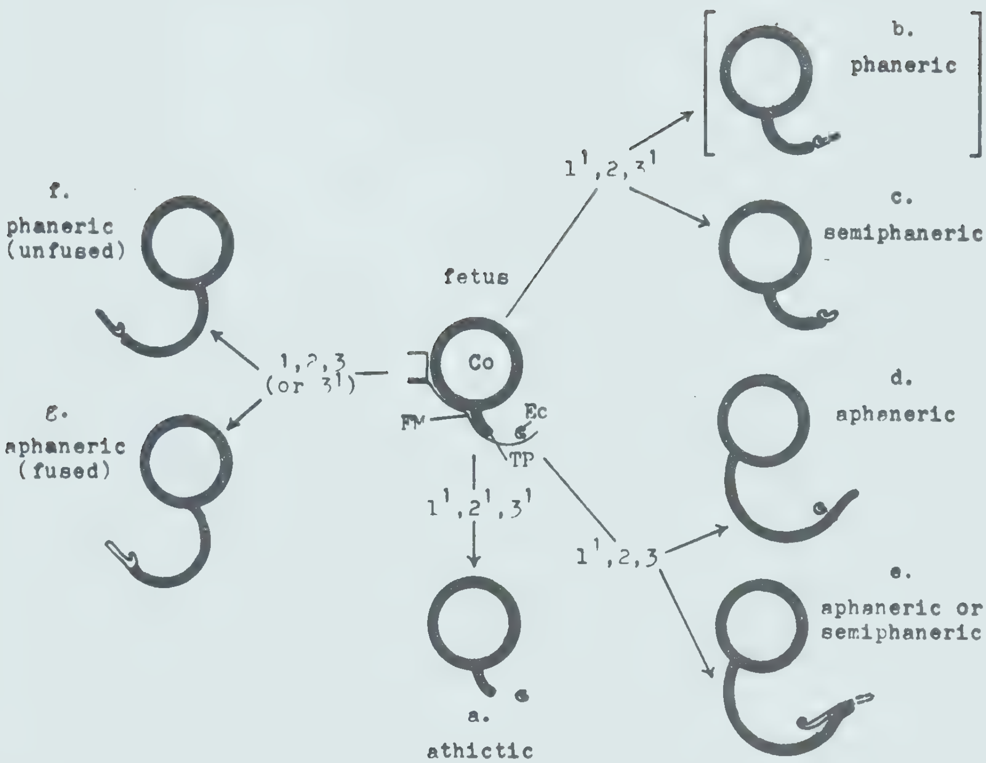

b.
phaneric
$1^1, 2, 3^1$
c.
semiphaneric
f.
phaneric
(unfused)
fetus
Co
1,2,3
(or 3^1)
d.
aphaneric
g.
aphaneric
(fused)
FM
Ec
TP
$1^1, 2^1, 3^1$
$1^1, 2, 3$
e.
aphaneric or
semiphaneric
a.
athictic

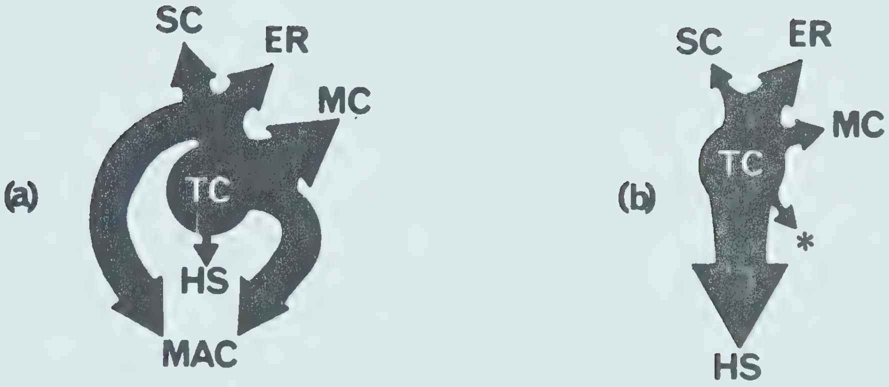
FIG. VIII-2 Schematic depiction of the progress of middle ear pneumatization in lorises (a) and lemurs (b).

The central circle (TC) represents the limits of the tympanic cavity proper immediately before the onset of pneumatization. The arrows indicate, in a rough way, the major trajectories of pneumatic activity and the relative positions of principal spaces in the adult stage.

The lorisiform pattern is characterized by intense pneumatic activity in the central and posterior parts of the dorsal wall. There is almost no pneumatization in the ventral part of the tympanic cavity, and hence the hypotympanic sinus is barely indicated in the adult (indicated by the narrow width of its arrow).

The lemuriform pattern is effectively the reverse. The ventral wall is strongly affected by pneumatization; the central and posterior parts of the dorsal wall are pneumatized to some extent, but never to the degree seen in lorises.

ER, epitympanic recess; HS, hypotympanic sinus; MAC, medial accessory cavity; MC, mastoid cavity; SC, supracochlear cavity; *, innominate diverticulum associated with the posterior septum.


(a)
SC
ER
MC
TC
HS
MAC
(b)
SC
ER
MC
TC
*
HS

BIBLIOGRAPHY

Abbreviations conform to entries in Biosis list of serials (BioSciences Information Service of Biological Abstracts, Philadelphia 1975). Style of citation is that employed by the journal *Folia primatologica* (Karger, Basel).

ADAMS, W.E.: The extracranial carotid rete and carotid fork in *Nycticebus coucang*. Ann. Zool., Agra 2:21-37 (1957).

ALLEN, J.A.: The external ear bone in certain rodents. Bull. am. Mus. nat. Hist. 20:135-138 (1904).

ALLEN, J.A.: Notes on *Solenodon paradoxus* Brandt. Bull. am. Mus. nat. Hist. 24:505-517 (1908).

ANSON, B.J.; BAST, T.H., and RICHANY, S.F.: The fetal and early post-natal development of the tympanic ring and related structures in man. Ann. Otol. Rhinol. Laryngol. 57:103-128 (1955).

ANSON, B.J. and DONALDSON, J.A.: The surgical anatomy of the temporal bone and ear; 2nd ed. (Saunders, Philadelphia 1973).

AREY, L.B.: Developmental anatomy, a textbook and laboratory manual of embryology; rev. 7th ed. (Saunders, Philadelphia 1974).

ASK-UPMARK, E.: On the entrance of the carotid cartery into the cranial cavity in *Stenops gracilis* and *Otolicnus crassicaudatus*. Acta anat. 19:101-103 (1953).

BÄHLER, H.: Das Primordialcranium des Halbaffen *Microcebus murinus*; med. Diss. Bern (1938).

BAKER, M.A.: Influence of the carotid rete on brain temperature in cats exposed to hot environments. J. Physiol., Lond. 220:711-728 (1972).

BAKER, M.A. and HAYWARD, J.N.: Carotid rete and brain temperature of cat. Nature, Lond. 216:139-141 (1967).

BAKER, M.A. and HAYWARD, J.N.: The influence of the nasal mucosa and the carotid rete upon hypothalamic temperature in sheep. J. Physiol., Lond. 198:561-579 (1968).

BAST, T.H. and ANSON, B.J.: The temporal bone and the ear (Charles C. Thomas, Springfield 1949).

BAST, T.H. and FORESTER, H.B.: Origin and distribution of air cells in the temporal bone. Arch. Otolaryngol. 30:225-249 (1939).

BATSON, O.V.: The applied anatomy of the temporal bone; in G.M. ENGLISH Otolaryngology, vol. 1, ch. 2, pp. 1-20 (Harper & Row, Hagerstown 1976).

BAXTER, J.S.: Frazer's manual of embryology; 3rd ed. (Baillière, Tindall and Cox, London 1953).

BEER, G.R. DE: Studies on the vertebrate head. II. The orbitotemporal region of the skull. Q.J. microsc. Sci. 70:263-370 (1926).

BEER, G.R. DE: The development of the skull of the shrew. Phil Trans. R. Soc. Lond. B217:411-480 (1929).

BEER, G.R. DE: The development of the vertebrate skull (Clarendon Press, Oxford 1937).

BEER, G.R. DE: Embryos and ancestors; 3rd ed. (Clarendon Press, Oxford 1958).

BEER, G.R. DE and WOODGER, J.H.: The early development of the skull in the rabbit. Phil. Trans. R. Soc. Lond. B218:373-414 (1930).

BLOOM, W. and FAWCETT, D.W.: A textbook of histology; 9th ed. (Saunders, Philadelphia 1968).

BONDY, G.: Beiträge zur vergleichenden Anatomie des Gehörorgans der Säuger (Tympanicum, Membrana Shrapnelli und Chordaverlauf). Anat. Hefte 34:293-408 (1907).

BOULAY, G.H. DU and VERITY, P.M.: The cranial arteries of mammals (Heinemann, London 1973).

BROERS, C.-J.: La position taxonomique de _Tupaia_ parmi les primates basée entre autres sur la structure de sa caisse du tympan (communication préliminaire). C.R. Assoc. Anat. 116:361-375 (1963).

BROMANN, I.: Die Entwickelungsgeschichte der Gehörknöchelchen beim Menschen. Anat. Hefte 11:507-670 (1899).

BROOM, R.: On the structure of the skull in _Chrysochloris_. Proc. zool. Soc. Lond. 1916:449-459 (1916).

BROTERENBROOD, E.C.: Concise catalogue of the central embryological collection of the Hubrecht laboratory (Hubrecht Laboratory, Utrecht 1977).

BUGGE, J.: The cephalic arterial system in the insectivores and primates with special reference to the Macroscelidoidea and Tupaioidea and the insectivore-primate boundary. Z. Anat. Entwicklungsgesch. 135:274-300 (1972).

BUGGE, J.: The cephalic arterial system in insectivores, primates, rodents, and lagomorphs, with special reference to the systematic classification. Acta anat. 87:suppl 62, pp. 1-160 (1974).

BUTLER, P.M.: On the evolution of the skull and teeth in the Erinaceidae, with special reference to fossil material in the British Museum. Proc. zool. Soc. Lond. 1948:446-500 (1948).

BUTLER, P.M.: The skull of Ictops and the classification of the Insectivora. Proc. zool. Soc. Lond. 1956:453-481 (1956).

BUTLER, P.M.: Insectivores and bats from the Miocene of East Africa: new material; in L.S.B. LEAKEY Fossil vertebrates of Africa, vol. 1, pp. 1-37 (Academic Press, London 1969).

BUTLER, P.M.: The problem of insectivore classification; in K.A. JOYSEY and T.R. KEMP Studies in vertebrate evolution, pp. 253-265 (Oliver and Boyd, Edinburgh 1972).

BUTLER, P.M. and HOPWOOD, A.T.: Insectivora and Chiroptera from the Miocene rocks of Kenya Colony. Br. Mus. nat. Hist. foss. Mamm. Afr. 13:1-35 (1957).

CAMPBELL, C.B.G.: Taxonomic status of tree shrews. Science, N.Y. 153:436 (1966).

CARLSSON, A.: Die Macroscelididae und ihre Beziehungen zu den übrigen Insectivoren. Zool. Jahrb., Abt. Syst., Ökol., Geogr. 28:349-400 (1909).

CARTMILL, M.: Arboreal adaptations and the origin of the order primates; in R. TUTTLE The functional and evolutionary biology of primates, pp. 97-122 (Aldine, Chicago 1972).

CARTMILL, M.: Rethinking primate origins. Science, N.Y. 184:436-443 (1974).

CARTMILL, M.: Strepsirhine basicranial structures and the affinities of the Cheinogaleidae; in W.P. LUCKETT and F.S. SZALAY Phylogeny of the primates, a multidisciplinary approach, pp. 313-354 (Plenum Press, N.Y. 1975).

CHARLES-DOMINIQUE, P. and MARTIN, R.D.: Evolution of lorises and lemurs. Nature, Lond. 227:257-260 (1970).

CLARK, W.E. LE GROS: On the skull of Tupaia. Proc. zool. Soc. Lond. 1925:559-567 (1925).

CLARK, W.E. LE GROS: On the anatomy of the pentailed tree shrew (Ptilocercus lowii). Proc. zool. Soc. Lond. 1926:1179-1309 (1926).

CLARK, W.E. LE GROS: The brain of Insectivora. Proc. zool. Soc. Lond. 1933:975-1013 (1933).

CLARK, W.E. LE GROS: Early forerunners of man (Baillière, Tindall and Cox, London 1934).

CLARK, W.E. LE GROS: The antecedents of man, an introduction to the evolution of the primates; 1st ed. (Edinburgh University Press, Edinburgh 1959).

CLARK, W.E. LE GROS: The antecedents of man, an introduction to the evolution of the primates; 3rd ed. (Quadrangle Books, Chicago 1971).

CLEMENS, W.: Fossil mammals of the type Lance Formation, Wyoming. Part 2, Marsupialia. Univ. Calif. Publ. Geol. Sci. 62:1-122 (1966).

CLEMENS, W.: Purgatorius, an early paromomyid primate (Mammalia). Science, N.Y. 184:903-905 (1974).

COOPER, C. FORSTER: On the ear region of certain of the Chrysochloridae. Phil. Trans. R. Soc. Lond. B216:265-281 (1928).

CORBET, G.B. and HANKS, J.: A revision of the elephant-shrews, family Macroscelididae. Bull. br. Mus. nat. Hist. Zool. 16:5-111 (1968).

CORSY, F.: Évolution de l'appareil hyo-branchial (P. Ciafra, Marseille 1933).

DALLOS, P.: Low-frequency auditory characteristics: species dependence. J. acoust. Soc. Am. 48:489-499 (1970).

DALLOS, P.: The auditory periphery. (Academic Press, London 1973).

DANIEL, P.M.; DAWES, J.D.K., and PRICHARD, M.M.L.: Studies of the carotid rete and its associated arteries. Phil. Trans. R. Soc. Lond. B237:173-204 (1953).

DAVIES, D.V.: Gray's anatomy, descriptive and applied; 34th ed. (Longmans, London 1967).

DAVIES, D.V. and DAVIES, F.: Gray's anatomy, descriptive and applied; 33rd ed. (Longmans, London 1962).

DAVIS, D.D.: Comparative anatomy and the evolution of the vertebrates; in G.L. JEPSEN, E. MAYR and G.G. SIMPSON Genetics, paleontology and evolution, pp. 64-89 (Atheneum, N.Y. 1963; reprint of 1949 ed.).

DE BEER, G.R.: vide BEER, G.R. DE.

DE LA TORRE, E. and NETSKY, M.G.: vide TORRE, E. DE LA and NETSKY, M.G.

DENE, H.; GOODMAN, M.; PRYCHODKO, W., and MOORE, G.W.: Immunodiffusion systematics of the primates. III. The Strepsirhini. Folia primatol. 25:35-61 (1976).

DIAMANT, M.: Otitis and pneumatization of the mastoid bone. Acta oto-laryngol., suppl. 41, pp. 1-149 (1940).

DU BOULAY, G.H. and VERITY, P.M.: vide BOULAY, G.H. DU and VERITY, P.M.

ELLERMAN, J.R.; MORRISON-SCOTT, T.C.S., and HAYMAN, R.W.: Southern African mammals 1758 to 1951: a reclassification (British Museum, London 1953).

ELOFF, F.C.: The homology of the mammalian pterygoid in the light of some new evidence. Proc. Linn. Soc. Lond. 162:56-63 (1950).

EVANS, F.G.: The osteology and relationships of the elephant shrews (Macroscelididae). Bull. am. Mus. nat. Hist. 80:85-125 (1942).

FAWCETT, E.: The primordial cranium of Erinaceus europaeus. J. Anat. 52:211-250 (1918).

FAWCETT, E.: The primordial cranium of Miniopterus schreibersi at the 17 millimetre total length stage. J. Anat. 53:315-350 (1919).

ENLOW, D.H.: A study of the post-natal growth and remodelling of bone. Am. J. Anat. 110:79-101 (1962).

FIEDLER, W.: Übersicht über das System der Primaten; in H. HOFER, A.H. SCHULTZ, and D. STARCK Primatologia, vol. 1, pp. 1-266 (Karger, Basel 1956).

FINDLAY, G.H.: The development of the auditory ossicles in the elephant shrew, the tenrec and the golden mole. Proc. zool. Soc. Lond. 1944:91-99 (1944).

FLEISCHER, G.: Studien am Skelett des Gehörorgans der Säugertiere, einschliesslich des Menschen. Saugetierk. Mitt. 21:131-239 (1973).

FLOWER, W.H.: On the value of the characters of the base of the cranium in the classification of the order Carnivora, and on the systematic position of Bassaris and other disputed forms. Proc. zool. Soc. Lond. 1869:4-37 (1869).

FORSTER, A.: L'inclinaison du tympan chez les mammifères supérieurs et chez l'homme. Arch. Anat. Histol. Embryol. 4:295-321 (1925).

FORSTER COOPER, C.: vide COOPER, C. FORSTER.

FORSYTH MAJOR, C.I.: vide MAJOR, C.I. FORSYTH.

FREI, H.: Das Primordialcranium eines Fetus von Avahis laniger; med. Diss. Bern (1938).

FRICK, H.: Zur Morphogenese der Fenestra rotunda. Verh. Anat. Ges. (50. Versamml., Marburg):194-203 (1952).

FRICK, H.: Die Entwicklung und Morphologie des Chondrokraniums von Myotis (Beitrag zur Kenntnis der Morphologie und Entwicklung des Chiropterkraniums III) (Georg Thieme, Stuttgart 1954).

GASC, J.P.: Sur une fenestration de la base du crâne chez les espèces de petite taille du genre Suncus Ehrenburg. Mammalia 27:81-91 (1963).

GAUNT, W.A.: Microreconstruction (Pitman, London 1971).

GAUPP, E.: Beiträge zur Morphologie des Schädels. III. Zur vergleichenden Anatomie der Schläfengegend am knöchernen Wirbelthier-Schädel. Morphol. Arb. 4:77-128 (1895).

GAUPP, E.: Das Chondrocranium von Lacerta agilis. Ein Beitrag zum Verständnis des Amniotenschädels. Anat. Hefte 14:433-439 (1900).

GAUPP, E.: Neue Deutungen auf dem Gebiete der Lehre vom Saugetierschadel. Anat. Anz. 27:273-310 (1905).

GAWNE, C.E.: The genus Proterix (Insectivora, Erinaceidae) of the upper Oligocene of North America. Am. Mus. Novit. 2315:1-26 (1968).

GETTY, R.: The ear; in M.E. MILLER, G.C. CHRISTENSEN and H.E. EVANS Anatomy of the dog, pp. 847-863 (Saunders, Philadelphia 1964).

GILLETTE, R.G.; BROWN, R.; HERMAN, P.; VERNON, S., and VERNON, J.: The auditory sensitivity of the lemur. Am. J. phys. Anthropol. 38:365-370 (1973).

GINGERICH, P.D.: Anatomy of the temporal bone in the Oligocene anthropoid Apidium and the origin of Anthropoidea. Folia primatol. 19:329-337 (1973).

GINGERICH, P.D.: Cranial anatomy and evolution of early Tertiary Plesiadapidae (Mammalia, Primates). Univ. Michigan Pap. Paleontol. 15:1-141 (1976).

GOODMAN, M.: Protein sequence and immunological specificity: their role in phylogenetic studies of primates; in W.P. LUCKETT and F.S. SZALAY Phylogeny of the primates, a multidisciplinary approach, pp. 219-248 (Plenum Press, N.Y. 1975).

GOODRICH, E.S.: Studies on the structure and development of vertebrates (Macmillan, London 1930).

GOULD, S.J.: Ontogeny and the explanation of form: an allometric analysis. J. Paleontol. 42:81-98 (1968).

GREGORY, W.K.: The orders of mammals. Bull. am. Mus. nat. Hist. 27:3-524 (1910).

GREGORY, W.K.: I. On the relationship of the Eocene lemur Notharctus to the Adapidae and to other primates. II. On the classification and phylogeny of the Lemuroidea. Bull. geol. Soc. Am. 26:419-446 (1915).

GREGORY, W.K.: On the structure and relations of Notharctus, an American Eocene primate. Mem. am. Mus. nat. Hist. 3:49-243 (1920).

GROVES, C.P.: Taxonomy and phylogeny of prosimians; in R.D. MARTIN, G.A. DOYLE and A.C. WALKER Prosimian biology, pp. 449-473 (Duckworth, London 1974).

GUTH, C.; HEIM DE BALSAC, H., and LAMOTTE, M.: Recherches sur la morphologie de Micropotamogale lamottei et l'évolution des Potamogalinae. I. Ecologie, denture, anatomie crânienne. Mammalia 23:423-447 (1959).

HAECKEL, E.: Generelle Morphologie der Organismen (Reimer, Berlin 1866).

HAINES, R.W. and MOHUIDDIN, A.: Metaplastic bone. J. Anat. 103:527-538 (1968).

HALL, B.K.: A histochemical study of the condylar secondary cartilage of the mouse, Mus musculus (Mammalia:Rodentia). Aust. J. Zool. 16:807-813 (1968).

HEFFNER, H.; RAVIZZA, R., and MASTERTON, B.: Hearing in primitive mammals. III. Tree shrew (Tupaia glis). J. aud. Res. 9:12-18 (1969).

HENCKEL, K.O.: Zur Entwicklungsgeschichte des Halbaffenschädels. Z. Morphol. Anthropol. 26:365-383 (1927).

HENCKEL, K.O.: Studien über das Primordialcranium und die Stammesgeschichte der Primaten. Morphol. Jahrb. 59:105-178 (1928).

HENSON, O.W.: Some morphological and functional aspects of certain structures of the middle ear in bats and insectivores. Univ. Kansas Sci. Bull. 42:151-255 (1961).

HERSHKOVITZ, P.: The ectotympanic bone and origin of higher primates. Folia primatol. 22:237-242 (1974).

HIGBEE, D.: Functional anatomy of the autonomic nervous system; in G.M. ENGLISH Otolaryngology, vol. 3, ch. 21a, pp. 1-16 (Harper & Row, Hagerstown 1975).

HILL, W.C.O.: Primates: comparative anatomy and taxonomy. I. Strepsirhini (Edinburgh University Press, Edinburgh 1953).

HINCHCLIFFE, R. and PYE, A.: Variations in the middle ear of the Mammalia. J. Zool., Lond. 157:277-288 (1969).

HOLLARD, M.H.: Du temporal et des pièces qui en représentent les éléments dans la série des animaux vertébrés. Ann. Sci. nat. Zool. Biol. anim. 1:359-376 (1864). [Cited in VAN DER KLAAUW 1922.]

HOYTE, D.A.N.: The postnatal growth of the ear capsule in the rabbit. Am. J. Anat. 108:1-16 (1961).

HOYTE, D.A.N.: Experimental investigations of skull morphology and growth. Int. Rev. Gen. Exp. Zool. 2:345-407 (1966).

HUNT, R.M.: The auditory bulla in Carnivora: an anatomical basis for reappraisal of carnivore evolution. J. Morphol. 143:21-76 (1974).

HYRTL, J.: Vergleichend-anatomische Untersuchungen über das innere Gehörorgan des Menschen und der Säugethiere (Prague, 1845). [Cited in GREGORY 1910.]

HYRTL, J.: Zur vergleichended Anatomie der Trommelhöhle. Denkschr. kais. Acad. Wiss., Wien (1850). [Cited in VAN KAMPEN 1905.]

JOHNSTON, T.B.; DAVIES, D.V., and DAVIES, F.: Gray's anatomy, descriptive and applied; 32nd ed. (Longmans, London 1958).

JONES, F. WOOD and LAMBERT, V.F.: The occurrence of the lemurine form of the ectotympanic in a primitive marsupial. J. Anat. 74: 72-72 (1939).

KAMPEN, P.N. VAN: Die Tympanalgegend des Säugetierschädels. Morphol. Jahrb. 34:321-722 (1905).

KAMPEN, P.N. VAN: De phylogenie van het entotympanicum. Tijds. nederl. dierk. Ver. 14:24-36 (1915).

KANAGASUNTHERAM, R. and KANAN, C.F.: The chondrocranium of a 19 mm C.R. length embryo of Galago senegalensis senegalensis. Acta zool., Stockh. 45:107-121 (1964).

KANAGASUNTHERAM, R. and KRISHNAMURTI, A.: Observations on the carotid rete in the lesser busy baby (Galago senegalensis senegalensis). J. Anat. 99:861-875 (1965).

KEEN, J.A. and GROBBELAAR, C.S.: The comparative anatomy of the tympanic bulla and auditory ossicles, with a note suggesting their function. Trans. R. Soc. S. Afr. 28:307-329 (1941).

KERMACK, K.A. and KIELAN-JAWOROWSKA, Z.: Therian and non-therian mammals; in D.M. KERMACK and K.A. KERMACK Early mammals, Zool. J. Linn. Soc. Lond. 50:suppl. 1, pp. 103-115 (Academic Press, London 1971).

KIELAN-JAWOROWSKA, Z.: Unknown structures in multituberculate skull. Nature, Lond. 226:974-976 (1970).

KIELAN-JAWOROWSKA, Z.: Preliminary description of two new eutherian genera from the late Cretaceous of Mongolia; in Z. KIELAN-JAWOROWSKA Results of the Polish-Mongolian Palaeontological Expeditions--Part VI, Palaeontol. Pol. 33:5-15 (1975).

KEIBEL, F.: The development of the sense-organs; in F. KEIBEL and F.P. MALL Manual of human embryology, vol. 2, pp. 180-290 (Lippincott, Philadelphia 1912).

KLAAUW, C.J. VAN DER: Über die Entwickelung des Entotympanicums. Tijds. nederl. dierk. Ver. 18:135-174 (1922).

KLAAUW, C.J. VAN DER: Die Skelettstücken in der Sehne des musculus stapedius und nahe dem Ursprung der Chorda tympani. Z. Anat. Entwicklungsgesch. 69:32-83 (1923).

KLAAUW, C.J. VAN DER: On the development of the tympanic region of the skull in the Macroscelididae. Proc. zool. Soc. Lond. 1929: 491-560 (1929).

KLAAUW, C.J. VAN DER: On mammalian auditory bullae showing an indistinct complex structure in the adult. J. Mammal. 11:55-60 (1930).

KLAAUW, C.J. VAN DER: The auditory bulla in some fossil mammals, with a general introduction to this region of the skull. Bull. am. Mus. nat. Hist. 62:1-352 (1931).

KOSKINEN, L.; ISOTUPA, K., and KOSKI, K.: A note on craniofacial growth. Am. J. phys. Anthropol. 45:511-516 (1976).

KÖSTLIN, O.: Der Bau des knöchernen Kopfes in den vier Klassen der Wirbelthiere (Stuttgart 1844). [Cited in VAN KAMPEN 1905.]

KRISHNAMURTI, A.: The cerebral arteries of Nycticebus coucang coucang. Folia primatol. 8:159-168 (1968).

KÜHN, H.-J.: Die Entwicklung und Morphologie des Schädels von Tachyglossus aculateus. Abh. Senckenb. Naturforsch. Ges. 528: 1-224 (1971).

LAMBERTON, C.: Contribution à la connaissance de la faune subfossile de Madagascar. Note IX. Oreille osseuse des lémuriens. Mém. Acad. Malgache 35:1-132 (1941).

LAY, D.M.: The anatomy, physiology, functional significance and evolution of specialized hearing organs of gerbilline rodents. J. Morphol. 138:41-120 (1972).

LECHE, W.: Über die Säugethiergattung Galeopithecus. Kongl. svenska Vetensk. Akad. Handl. 21(11):1-92 (1885).

LECHE, W.: Zur Entwicklungsgeschichte des Zahnsystems der Säugethiere. Thiel II: Phylogenie. Heft I: Die Familie der Erinaceidae. Zoologica, Stuttg. 37:1-103 (1902.

LE GROS CLARK, W.E.: vide CLARK, W.E. LE GROS.

LEIMGRUBER, C.: Le crâne primordial d'un embryon de Centetes ecaudatus. Biomorphosis 1:545-585 (1939).

LUCKETT, W.P.: Comparative development and evolution of the placenta in primates; in W.P. LUCKETT Reproductive biology of the primates, Contrib. primatol. 3:142-234 (1974).

LYON, M.W.: Tree shrews: an account of the mammalian family Tupaiidae. Proc. U.S. natl Mus. 45:1-188 (1913).

MACINTYRE, G.T.: The trisulcate petrosal pattern of mammals; in T. DOBZHANSKY, M.K. HECHT and W.C. STEERE Evolutionary biology, vol. 6, pp. 275-303 (Appleton-Century-Crofts, N.Y. 1972).

MACPHEE, R.D.E.: Ontogeny of the ectotympanic-petrosal plate relationship in strepsirhine prosimians. Folia primatol. 27:245-283 (1977).

MAJOR, C.I. FORSYTH: Exhibition of, and remarks upon, some skulls of fetal Malagasy lemurs. Proc. zool. Soc. Lond. 1899:987-988 (1899).

MARTIN, R.D.: Reproduction and ontogeny in tree shrews (Tupaia belangeri), with reference to their general behavior and taxonomic relationships. Z. Tierpsychol. 25:409-532 (1968a).

MARTIN, R.D.: Towards a new definition of primates. Man 3:377-401 (1968b).

MASTERTON, B.; HEFFNER, H., and RAVIZZA, R.: The evolution of human hearing. J. acous. Soc. Am. 45:966-985 (1969).

MCCRADY, E.: The embryology of the oppossum. Am. Anat. Mem. 16: 1-233 (1938).

MCDOWELL, S.B.: The Greater Antillean insectivores. Bull. am. Mus. nat. Hist. 115:113-214 (1958).

MCKENNA, M.C.: New evidence against the tupaioid affinities of the mammalian family Anagalidae. Am. Mus. Novit. 2158:1-16 (1963).

MCKENNA, M.C.: Paleontology and the origin of the primates. Folia primatol. 4:1-25 (1966).

MCKENNA, M.C.: Toward a phylogenetic classification of the Mammalia; in W.P. LUCKETT and F.S. SZALAY Phylogeny of the primates, a multidisciplinary approach, pp. 21-46 (Plenum Press, N.Y. 1975).

MEISTER, W. and DAVIS, D.D.: Placentation of the pigmy tree shrew (Tupaia minor). Fieldiana Zool. 35:71-84 (1956).

MØLLER, A.R.: The middle ear; in P.V. TOBIAS Foundations of modern auditory theory, vol. 2, pp. 133-194 (Academic Press, N.Y. 1972).

MOFFETT, B.C.: A research perspective on craniofacial morphogenesis. Acta morphol. neerl. -scand. 10:91-101 (1972).

MOSS, M.L.: Growth of the calvaria in the rat. Am. J. Anat. 94: 333-362 (1954).

MOSS, M.L.: Fusion of the frontal suture in the rat. Am. J. Anat. 102:141-165 (1958).

MOSS, M.L.: Inhibition and stimulation of sutural fusion in the rat calvaria. Anat. Rec. 136:457-468 (1960).

MOSS, M.L.: Ontogenetic aspects of cranio-facial growth; in R.E. MOYERS and W.M. KROGMAN Cranio-facial growth in man, pp. 109-124 (Pergamon Press, Oxford 1971).

MURRAY, P.D.F.: Cartilage and bone: a problem in tissue differentiation. Aust. J. Sci. 14:65-73 (1957).

NAPIER, J.R. and NAPIER, P.H.: A handbook of living primates. (Academic Press, London 1967).

OAKS, E.C.: Structure and function of inflated middle ears of rodents; PhD Diss. Yale (1967).

OJALA, L.: Contribution to the physiology and pathology of mastoid air-cell formation: histological studies of aged individuals and newborn infants. Acta oto-laryngol., suppl. 86, pp. 1-134 (1950).

OJALA, L.: Pneumatization of the bone and environmental factors: experimental studies on chick humerus. Acta oto-laryngol., suppl. 133, pp. 1-28 (1957).

OPHEIM, O.: The pneumatic conditions of the human temporal bone in the light of experimental researches on the development of the air space in the chick humerus. Acta oto-laryngol., suppl. 54, pp. 1-116 (1944).

PADGET, D.H.: The development of the cranial arteries in the human embryo. Contrib. Embryol. Carnegie Inst., no. 212, 32:205-261 (1948).

PARKER, W.K.: On the structure and development of the skull in Mammalia. Part III. Insectivora. Phil. Trans. R. Soc. Lond. 176:121-275 (1886).

PATTERSON, B.: The fossil elephant shrews (family Macroscelididae). Bull. Mus. comp. Zool., Harv. Coll. 133:295-335 (1965).

PEARSON, A.A. and JACOBSON, A.D.: The development of the ear (American Academy of Ophthalmology and Otolaryngology, Rochester 1967).

PETERS, W.C.H.: Naturwissenchaftliche Reise nach Mossambique. Zoologie. I. Säugethiere (Berlin 1842). [Cited in VAN DER KLAAUW 1929.]

PRITCHARD, J.J.; SCOTT, J.H., and GIRGIS, F.G.: The structure and development of cranial and facial sutures. J. Anat. 90:73-86 (1956).

PROCTOR, B.: Embryology and anatomy of the eustachian tube. Arch. Otolaryngol. 86:503-514 (1967).

PUSEY, H.K.: Methods of reconstruction from microscopic sections. J.R. microsc. Soc. 59:232-244 (1939).

PYE, A. and HINCHCLIFFE,R.: Structural variations in the mammalian middle ear. Med. biol. Illus. 18:122-127 (1968).

RAMASWAMI, L.S.: The development of the skull in the slender loris, Loris tardigradus lydekkerianus Cabr. Acta zool., Stockh. 38:27-68 (1957).

REINBACH, W.: Zur Entwicklung des Primordialcraniums von Dasypus novemcinctus Linné (Tatusia novemcincta Lesson) II. Z. Morphol. Anthropol. 45:1-72 (1952).

RICH, T.H.V. and RICH, P.V.: Brachyerix, a Miocene hedgehog from western North America, with a description of the tympanic regions of Paraechinus and Podogymnura. Am. Mus. Novit. 2477:1-58 (1971).

RICHANY, S.F.; ANSON, B.J., and BAST, T.H.: The ear and the temporal bone, development and adult structure; in G.M. ENGLISH Otolaryngology, vol. 1, ch. 1, pp. 1-140 (Harper & Row, Hagerstown 1975).

ROUX, G.H.: The cranial development of certain Ethiopian 'insectivores' and its bearing on the mutual affinities of the group. Acta zool., Stockh. 28:165-397 (1947).

RUËDI, L.: Die Mittelohrraumentwicklung vom 5. Embryonalmonat bis zum 10. Lebensjahr. Acta oto-laryngol., suppl. 22, pp. 1-134 (1937).

RUGH, R.: A guide to vertebrate development; 6th ed. (Burgess, Minneapolis 1971).

RUSSELL, D.E.: Les mammifères paléocenes d'Europe. Mém. Mus. natl Hist. nat., Paris, Sér. C 13:1-321 (1964).

SABAN, R.: Phylogénie des insectivores. Bull. Mus. natl Hist. nat., Paris, ser. 2 26:419-432 (1954).

SABAN, R.: Les affinités du genre *Tupaia* Raffles 1821, d'après les caractères morphologiques de la tête osseuse. Ann. Paléontol. 42: 169-224 (1956); 43:1-44 (1957).

SABAN, R.: Contribution à l'étude de l'os temporal des primates. Description chez l'homme et les prosimiens. Anatomie comparée et phylogénie. Mém. Mus. natl Hist. nat., Paris, Ser. A 29: 1-378 (1963).

SABAN, R.: Sur la pneumatisation de l'os temporal des Primates adultes et son développement ontogenique chez le genre *Alouatta* (Platyrhinien). Morphol. Jahrb. 106:569-593 (1964).

SCHNEIDER, R.: Zur Entwicklung des Chondrocraniums der Gattung *Bradypus*. Morphol. Jahrb. 95:210-301 (1955).

SEGALL, W.: The middle ear region of *Dromicipos*. Acta anat. 72: 489-501 (1969a).

SEGALL, W.: The auditory ossicles (malleus, incus) and their relationships to the tympanic: in marsupials. Acta anat. 73:176-191 (1969b).

SEGALL, W.: Morphological parallelisms of the bulla and auditory ossicles in some insectivores and marsupials. Fieldiana Zool. 51:169-205 (1970).

SEPPÄLÄ, A.J.: Variations in the pneumatic cell system of the temporal bone: acute otitis media and complications in varying types of pneumatisation. Acta. oto-laryngol., suppl. 64, pp. 1-131 (1946).

SICHER, H. and S.N. BHASKAR: Orban's oral histology and embryology; 7th ed. (Mosby, Saint Louis 1972).

SIMONETTA, A.: Anatomia e significato morfologico e sistematico dell' orecchio medio e delle strutture ad esso connesse in alcuni insettivori (*Suncus*, *Talpa*, *Chrysochloris*). Arch. ital. Anat. Embriol. 62:55-94 (1957a).

SIMONETTA, A.: Sull'esistenza digiunti cinetici nel cranio di alcuni insettivori (*Myosorex*, *Talpa*) e sul loro possibile significato. Monit. zool. ital. 64:172-180 (1957b).

SIMONETTA, A.: Condrocranio e dermascheletro di "Chrysochloris asiatica" (Linnaeus). Monit. zool. ital. 65:28-47 (1957c).

SIMONETTA, A.: Cranial kinesis and the morphology of the middle ear: two possibly related features. Evolution 17:580-587 (1963).

SIMONS, E.L.: Primate evolution, an introduction to man's place in nature (Macmillan, N.Y. 1972).

SIMONS, E.L.: Notes on early Tertiary prosimians; in R.D. MARTIN, G.A. DOYLE, and A.C. WALKER Prosimian biology, pp. 415-433 (Duckworth, London 1974).

SIMPSON, G.G.: The major features of evolution (Simon & Schuster, N.Y. 1953).

SIMPSON, G.G.: Primate taxonomy and recent studies of nonhuman primates. Ann. N.Y. Acad. Sci. 102:497-514 (1962).

SISSON, S.: The anatomy of the domestic animals; 3rd ed., rev. by J.D. GROSSMAN (Saunders, Philadelphia 1938).

SPATZ, W.B.: Beitrang zur Kenntnis der Ontogenese des Cranium von Tupaia glis (Diard 1820). Morphol. Jahrb. 106:321-416 (1964).

SPATZ, W.B.: Zur Ontogenese der Bulla tympanica von Tupaia glis Diard 1820 (Prosimiae, Tupaiiformes). Folia primatol. 4:26-50 (1966).

SPRAGUE, J.M.: The hyoid region in the Insectivora. Am. J. Anat. 74:175-216 (1944).

STADTMÜLLER, F.: Kranium und Visceralskelett der Säugetiere; in L. BOLK, E. GÖPPERT, E. KALLIUS, and W. LUBOSCH Handbuch der vergleichenden Anatomie der Wirbeltiere, vol. 4, pp. 839-1016 (Urban & Schwartzenburg, Berlin 1936).

STARCK, D.: Zur Morphologie des Primordialcraniums von Manis javanica Desm. Morphol. Jahrb. 86:1-122 (1941).

STARCK, D.: Das Cranium eines Schimpansenfetus (Pan troglodytes [Blumenbach 1799]) von 71 mm SchStlg., nebst Bemerkungen über die Körperform von Schimpansenfeten (Beitrag zur Kenntnis des Primatencraniums II). Morphol. Jahrb. 100:599-647 (1960).

STARCK, D.: Das Cranium von Propithecus spec. (Prosimiae, Lemuriformes, Indriidae) (Beiträge zur Kenntnis des Primaten-Craniums III). Bibl. primatol., vol. 1, pp. 163-196 (1962).

STARCK, D.: Über das Entotympanicum der Canidae und Ursidae (Mammalia, Carnivora, Fissipeda). Acta theriol. 8:181-188 (1964).

STARCK, D.: Embryologie, ein Lehrbuch auf allgemein biologischer Grundlage; 2nd ed. (Georg Thieme, Stuttgart 1965).

STARCK, D.: Le crâne des mammifères; in P. GRASSÉ Traité de zoologie, vol. 16, part 1, pp. 405-549, 1095-1102 (Masson, Paris 1967).

STARCK, D.: The development of the chondrocranium in primates; in W.P. LUCKETT and F.S. SZALAY Phylogeny of the primates, a multidisciplinary approach, pp. 127-155 (Plenum Press, N.Y. 1975).

STEHLIN, H.G.: Die Säugetiere des schweizerischen Eocaens. Siebenter Teil, erste Hälfte. Adapis. Abh. schweiz. paläont. Ges. 38: 1165-1298 (1912).

STEPHAN, H.: Bericht über eine belgisch-deutsche Gemeinschaftsexpedition in Belgish-Kongo. Mitt. Max-Planck-Ges. 2:96-106 (1958).

STEPHAN, H.: Forschungsreise nach Lemuria (Madagaskar). Mitt. Max-Planck-Ges. 5:318-333 (1963).

STEUERWALD, E.A.: Review of the phylogenetic position on the tree shrew (Tupaia glis Diard), with new observations on the arteria carotis interna; PhD Diss. Michigan State (1969).

STORY, H.E.: The carotid arteries in the Procyonidae. Fieldiana Zool. 32:477-557 (1951).

SZALAY, F.S.: The beginnings of primates Evolution 22:19-36 (1968).

SZALAY, F.S.: Mixodectidae, Microsyopidae, and the insectivore-primate transition. Bull. am. Mus. nat. Hist. 140:193-330 (1969).

SZALAY, F.S.: Cranial morphology of the early Tertiary Phenacolemur and its bearing on primate phylogeny. Am. J. phys. Anthropol. 36:59-76 (1972a).

SZALAY, F.S.: The paleobiology of the earliest primates; in R. TUTTLE The functional and evolutionary biology of primates, pp. 3-35 (Aldine, Chicago 1972b).

SZALAY, F.S.: Phylogeny of primate higher taxa: the basicranial evidence; in W.P. LUCKETT and F.S. SZALAY Phylogeny of the primates, a multidisciplinary approach, pp. 91-125 (Plenum Press, N.Y. 1975).

SZALAY, F.S.: Systematics of the Omomyidae (Tarsiiformes, Primates): taxonomy, phylogeny, and adaptations. Bull. am. Mus. nat. Hist. 156:157-450 (1976).

SZALAY, F.S. and KATZ, C.: Phylogeny of lemurs, galagos and lorises. Folia primatol. 19:88-103 (1973).

TANDLER, J.: Zur vergleichenden Anatomie der Kopfarterien bei den Mammalia. Denkschr. kais. Acad. Wiss., Wien 67:677-784 (1899).

TANDLER, J.: Zur Entwicklungsgeschichte der Kopfarterien bei den Mammalia. Morphol. Jahrb. 30:275-373 (1902).

TATTERSALL, I. and SCHWARTZ, J.H.: Craniodental morphology and the systematics of the Malagasy lemurs (Primates, Prosimii). Anthropol. Pap. am. Mus. nat. Hist. 52:139-192 (1974).

THOMAS, O. and SCHWANN, H.: The Rudd exploration of South Africa. V. List of mammals obtained by Mr. Grant in N.E. Transvaal. Proc. zool. Soc. Lond. 1906:575-591 (1906).

TONNDORF, J. and KHANNA, S.M.: The quality of impedance matching by the middle ears of cats. Ann. Otol. Rhinol. Laryngol. 77:154-163 (1968).

TORRE, E. DE LA and NETSKY, M.G.: Study of persistent primitive maxillary artery in human fetus: some homologies of cranial arteries in man and dog. Am. J. Anat. 106:185-195 (1960).

VALEN, L. VAN: Tree shrews, primates and fossils. Evolution 19: 137-151 (1965).

VALEN, L. VAN: New Paleocene Insectivora and insectivore classification. Bull. am. Mus. nat. Hist. 135:217-284 (1967).

VAN DER KLAAUW, C.J.: vide KLAAUW, C.J. VAN DER.

VAN KAMPEN, P.N.: vide KAMPEN, P.N. VAN.

VAN VALEN, L.: vide VALEN, L. VAN.

VERSLUYS, J.: Die mittlere und äussere Ohrsphäre der Lacertilia und Rhynchocephalia. Zool. Jahrb., Abt. Anat. Ontog. 12:161-406 (1898). [Cited in VAN DER KLAAUW 1922.]

WALKER, A.C.: A review of the Miocene Lorisidae of East Africa; in R.D. MARTIN, G.A. DOYLE and A.C. WALKER Prosimian biology, pp. 435-447 (Duckworth, London 1974).

WALKER, E.P.; WARNICK, F.; LANGE, K.I.; UIBLE, H.E.; HAMLET, S.E.; DAVIS, M.A., and WRIGHT, P.F.: Mammals of the world; 3 vols. (Johns Hopkins, Baltimore 1964).

WASSIF, K.: Studies on the structure of the auditory ossicles and tympanic bone in Egyptian Insectivora, Chiroptera, and Rodentia. Bull. Fac. Sci. Fouad I Univ. 27:177-213 (1948).

WEBER, M.: Die Säugetiere. Einführung in die Anatomie und Systematik der recenten und fossilen Mammalia; 2nd ed., 2 vols. (Fischer, Jena 1927-28).

WEBSTER, D.B.: The ear apparatus of the kangeroo rat, Dipodomys. Am. J. Anat. 108:123-148 (1961).

WEBSTER, D.B.: A function of the enlarged middle ear cavities of the kangeroo rat, Dipodomys. Physiol. Zool. 35:248-255 (1962).

WEBSTER, D.B.: Ear structure and function in modern mammals. Am. Zool. 6:451-466 (1966).

WEBSTER, D.B.: Auditory systems of Heteromyidae: postnatal development of the ear of Dipodomys merriami. J. Morphol. 146:377-394 (1975).

WEBSTER, D.B. and STROTHER, W.F.: Middle ear morphology and auditory sensitivity of heteromyid rodents. Am. Zool. 12:727 (1972).

WEBSTER, D.B. and WEBSTER, M.: Auditory systems of Heteromyidae: functional morphology and evolution of the middle ear. J. Morphol. 146:343-376 (1975).

WEGNER, R.N.: Die Paukeninnenbeine (Endotympanicum und Epipterygoid) bei den Säugetieren. Photographie und Forschung 3:289-303 (1942).

WEIDENREICH, F.: Das Knochengewebe; in W. VON MOLLENDORFF Handbuch der mikroscopischen Anatomie des Menschen, vol. 2, pp. 391-508 (Springer, Berlin 1930).

WEINMANN, J.P. and SICHER, H.: Bone and bones: fundamentals of bone biology; 2nd ed. (Mosby, Saint Louis 1955).

WERNER, C.F.: Das Mittel- und Innenohr; in H. HOFER, A.H. SCHULTZ and D. STARCK Primatologia, vol. 2, Teil 1, Lieferung 5, pp. 1-40 (Karger, Basel 1960a).

WERNER, C.F.: Das Gehörorgan der Wirbeltiere und des Menschen. Beispiel für eine vergleichende Morphologie der Lagesbeziehungen (VEB Georg Thieme, Leipzig 1960b).

WIŃCZA, H.: O niektórych zmianach rozwoju w okolicy osady głowy u zwierząt ssących. (Über einige Entwickelungsveränderungen in der Gegend des Schädelgrundes bei den Säugethieren). Bull. int. Acad. Sci. Cracovie 1896:326-337 (1896).

WINGE, H.: Jordfundne og nulevende Flagermus (Chiroptera) fra Lagoa Santa, Minas Geraes, Brasilien. Med Udsigt øver Flagermusenes indbyrdes Slaegtskab. E Museo Lundii 2(1):1-92 (1892). [Trans. by E. DIECHMANN and G.M. ALLEN appears in A.S. JENSEN, R. SPÄRCK and H. VØLSOE The interrelationships of the mammalian genera, vol. 1, Monotremata, Marsupialia, Insectivora, Chiroptera, Edentata (Reitzels, København 1941).]

WINGE, H.: Jordfundne og nulevende Aber (Primates) fra Lagoa Santa, Minas Geraes, Brasilien. Med Udsigt øver Abernes indbyrdes Slaegtskab. E Museo Lundii 2(2):1-57 (1895). [Trans. by E. DIECHMANN and G.M. ALLEN appears in A.S. JENSEN, R. SPÄRCK and H. VØLSOE The interrelationships of the mammalian genera, vol. 2, Rodentia, Carnivora, Primates (Reitzels, København 1941).]

WOOD JONES, F. and LAMBERT, V.F.: vide JONES, F. WOOD and LAMBERT, V.F.

WÜNSCH, D.: Zur Kenntnis der Entwicklung des Craniums des Koboldmaki, Tarsius bancanus borneanus, Horsfield, 1821 (Beiträge zur Kenntnis des Primaten-Craniums IV) (Selbstverlag Sencken. Anat. Inst., J.-W.-Goethe-Univ., Frankfurt/M 1975).

YUODELIS, R.H.: The morphogenesis of the human temporomandibular joint and its associated structures. J. dent. Res. 45:182-191 (1966).

A P P E N D I C E S

APPENDIX I

GENERAL FUNCTION OF THE MIDDLE EAR

The chief function of the middle ear is to transmit air-borne vibrations received by the tympanic membrane in such a way that they become strong enough to move the fluids of the internal ear. It does so by transforming the low-pressure, high-amplitude sound waves carried by the air into waves which are of smaller amplitude but of correspondingly greater pressure. The necessity for this transformation of acoustical energy is related to the air-water boundary problem. Air and water (or any other fluid) differ greatly in their compressibility and density, and hence in their characteristics for transmitting acoustical energy (technically described as their acoustic impedances). The middle ear matches these impedances, or in less complex terms, overcomes the opposition to energy flow.

Mechanically, transformation is accomplished in two ways. The force striking the tympanic membrane is concentrated into the far smaller footplate of the stapes, which has the effect of increasing the force per unit area (pressure). Secondly, the ossicular chain has leverage, which also has the effect of increasing pressure at the footplate.

This analysis is not complete, however, because it does not consider the energy dissipated or stored by the biological transformer and its associated structures. Stated in another way, the middle ear

exerts its own influence on the flow of energy, i.e., has its own impedance.

Energy flow in any mechanical system is affected by factors of friction, mass, and stiffness. The first factor (the 'resistive' component) is minimal in the case of the middle ear because the articulations of the delicately-suspended ossicles are normally enclosed in joint capsules. The other two, however, are important. Mass and stiffness are called the 'reactive' component of acoustic impedance, since they store energy. In doing so they reduce the overall efficiency of the middle ear mechanism by diverting part of the energy flow into potential energy. Mass is contributed by the tympanic membrane and ossicular chain. Stiffness is produced by many agencies, including the tension of the tympanic membrane, ossicular ligaments, anular legament of the fenestra vestibuli, tonus of the ossicular muscles and the volume of air enclosed within the middle ear.

Mass and stiffness stand in a specific, reciprocal relationship: mass reactance increases and stiffness reactance decreases with increasing frequency. Total reactance is the difference between mass and stiffness factors; but because the relationship is reciprocal, these two factors will cancel each other at some point in the frequency spectrum. This point is the resonant frequency, and at this frequency the transfer of acoustic energy is at its maximum. Experiments on several mammals establish that the resonant frequencies predicted by theoretical considerations actually correspond with the most sensitive frequency of these animals (DALLOS 1970; WEBSTER and WEBSTER 1975).

Middle ear morphology can affect the reactance offered by both the mass and stiffness factors. Alteration in either will also affect the position of the resonant frequency. If mass is great, sensitivity will be reduced for frequencies above the area of greatest sensitivity; if stiffness is great, sensitivity will be reduced for frequencies below the area of greatest sensitivity. Further, reduction of either factor will promote an increased degree of sensitivity above or below the resonant frequency.

APPENDIX II

DEFINITIONS

The first duty of the morphologist to his readers is clarity of description, and fundamental to the accomplishment of this duty is the proper and consistent use of anatomical terms. Structurally, the mammalian auditory region is one of the more complex parts of the body, and to describe it adequately one requires a similarly elaborate terminology.

In order to save the reader unnecessary labor, I have assembled a comprehensive glossary of anatomical terms which should considerably ease the task of visualizing the positions and relations of structures described in the text.

I have attempted to follow what I think is the most logical course regarding usage. First, I have chosen, in most instances, the English equivalents of names officially recognized by *Nomina anatomica* (third ed., 1966), *Nomina anatomica veterinaria* (first ed., 1968), and *Nomina embryologica* (first ed., June 1970 revision). (These are abbreviated in the text as NA, NAV, and NE, respectively.) Secondly, in cases where no official name was available for a structure which is otherwise well-known, I have selected what I believe to be the *au courant* term in the literature. Thirdly, in cases where structures have not been previously recognized, or where a recognized term is for one good reason or another inadequate, I have fashioned my own names. Finally, I have also listed, where appropriate, common

synonyms of the chosen names. Listed Latin names are usually, but not always, those recognized by the Nominae.

Generally speaking, the definitions accompanying each of the terms are paraphrases of definitions or descriptions in well-known works with good illustrations. These works are cited next to the corresponding definitions. Inverted commas indicate a direct quote. In other cases, the following convention is used. If the stated definition departs in only minor ways from an original source, only author, date and page number are listed. If the departure includes major alterations in phraseology or meaning, reference data are preceded by the verb "see". In several instances, suitably lucid or complete definitions could not be found, and I have coined my own.

ALA TEMPORALIS

A lateral appendage of the central stem which usually chondrifies independently, but which soon fuses to the processus alaris. It forms a considerable part of the floor of the cavum epiptericum, which lodges the trigeminal ganglion. (DE BEER 1929:453-454.)

In mammals, it is the representative of the processus ascendens of the pterygoquadrate cartilage, and therefore part of the visceral arch skeleton, which in phylogeny was completely distinct in origin from the processus alaris. (DE BEER 1937:450.)

ALICOCHLEAR COMMISSURE
(ANTERIOR TRABECULO-COCHLEAR COMMISSURE)

The transitory, cartilaginous bridge which joins the anterior pole of pars cochlearis to the processus alaris of the central stem. It forms the lateral border of the foramen caroticum primitivum, separating it from the piriform fenestra. (See DE BEER 1929:414.)

Although normally present in fetal mammals, its development may be so retarded that it completely fails to appear in the young stages of some forms (e.g., _Loris_, _Galago_). It usually disappears through resorption or de-differentiation, although ossification may extend into the commissure and so produce the lingula sphenoidale (case in _Homo_).

ALISPHENOID

A bone of the skull which contributes to the basicranium, orbit and other areas. It arises within the ala temporalis, although most of its growth is accomplished by intramembranous (periosteal) ossification. Fuses with the pterygoid and basisphenoid. (See DE BEER 1937:369-370.)

AN(N)ULUS MEMBRANE

According to some authors (e.g., VAN KAMPEN 1905; SABAN 1956-57, 1963), a special membrane which fastens the ventral rim of the ectotympanic to the internal aspect of the lateral bullar wall in certain mammals (e.g., tree shrews, lemurs).

In fact, the anulus membrane does not exist, at least as an entity separate from the tissues of the membranous meatus and the tunica mucosa of the tympanic cavity.

AN(N)ULUS TYMPANICUS

See ECTOTYMPANIC.

ANTERIOR BASICAPSULAR COMMISSURE
(SPHENOCOCHLEAR COMMISSURE)

The transitory, cartilaginous bridge which joins the anteromedial side of pars cochlearis to the basal plate of the central stem. It forms the anterior border of the basicapsular fenestra as well as the posterior border of the foramen caroticum primitivum. (See STARCK 1967:444.)

It is not constant, and in cases (or stages) where it is absent the basicapsular fenestra communicates with the foramen caroticum primitivum.

ANTERIOR CAROTID ARTERY
(CAROTIDE ANTÉRIEURE, ?ASCENDING PHARYNGEAL A., A. FORAMINIS LACERI, APPARENT INTERNAL CAROTID A.)

The large vessel found in strepsirhines which arises from the common carotid and which supplies most of the extravertebral arterial blood destined for the brain. Unlike the internal carotid, it does not enter the tympanic cavity, but instead travels outside it. The artery reaches the circulus arteriosus through the anterior carotid foramen. In lorises, the vessel bears a rete mirabile of simple structure.

CARTMILL (1975:324) believes that the anterior carotid is the homologue of the ascending pharyngeal artery of Homo and many other mammals. It is unlikely to be the medial carotid artery, since both the medial carotid and ascending pharyngeal artery are present in some mammals (e.g., carnivores).

ANTERIOR CAROTID FORAMEN

The bony foramen (or canal) of the osteocranium through which the promontorial artery (or the joint vessel formed by the anastomosis of the promontorial and anterior carotid or ascending pharyngeal or medial carotid) actually enters the cranial cavity. It is the ontogenetic successor of the foramen caroticum primitivum (q.v.) of the chondrocranium.

Various bones may participate in the bounding of this foramen, especially when it is prolonged into a canal. Further, it is sometimes confluent with the piriform fenestra. However, basisphenoidal material inevitably lies at least on the medial side of the intracranial aperture of the anterior carotid foramen, for the artery passing through the foramen emerges medial or slightly posteromedial to the position of the hypophysis.

This term is preferred to foramen lacerum medium, a term which has lost its valency because it is used in so many different ways. It should also be noted that a single foramen does not always succeed the foramen caroticum primitivum. Adult mammals sometimes have separate foramina in the base of the skull for the promontorial artery and anterior carotid (or medial carotid), or a separate foramen for veins draining intracranial sinuses. (See STORY 1951:513.)

ANTEROMEDIAL PROCESS (OF THE BULLA)
(PROCESSUS ANTEROMEDIALIS)

The moderately-inflated projection of the auditory bulla which lies on or points towards the basioccipital-basisphenoidal synchondrosis, medial to the tubal canal. (See VAN DER KLAAUW 1931:118.)

APERTURA (FOSSULAE) FENESTRAE VESTIBULI
(APERTURA FENESTRAE OVALIS)

"The vestibular window...is a transversely oval opening in the outer wall of the otic capsule; in the fresh state the fenestra is closed by the base of the stapes and the annular ligament" (RICHANY, ANSON and BAST 1975:104).

Unlike the fenestra cochleae (q.v.), the fenestra vestibuli is not deeply recessed within the auditory capsule. However, a fossula fenestrae vestibuli is named in the NA.

APERTURA FOSSULAE FENESTRAE COCHLEAE
(APERTURA FOSSULAE FENESTRAE ROTUNDAE)

The entrance to a diverticulum of the middle ear (the fossula fenestrae cochleae, q.v.) within which the secondary tympanic membrane is situated. It conforms to the "fenestra cochleae" (or "rotunda") of earlier authors who believed that the secondary tympanic membrane lay across the apertura itself. (See FRICK 1952.)

See also FOSSULA FENESTRAE COCHLEAE, FENESTRA COCHLEAE.

APERTURA LATERALIS OF THE RECESSUS SCALAE TYMPANI

The aperture of the cartilaginous otic capsule which is completed ventrally by the processus recessus and which becomes the fenestra cochleae of the osteocranium. (DE BEER 1929:461-466).

APERTURA MEDIALIS OF THE RECESSUS SCALAE TYMPANI

An aperture of the cartilaginous otic capsule which conducts the perilymphatic duct into the cranial cavity and which is completed ventrally by the processus recessus. This opening becomes the cochlear canaliculus after the ossification of the capsule. (DE BEER 1929:461-466.)

AQUEDUCTUS COCHLEAE

See COCHLEAR CANALICULUS

ARTERY OF THE PTERYGOID CANAL
(A. CANALIS PTERYGOIDEI, VIDIAN A.)

The artery which accompanies the nerves of the pterygoid canal through the passageway of the same name (see PTERYGOID CANAL). It is usually of insignificant size in recent mammals, and extremely variable in its connexions. However, it is probably an ancient branch of the mammalian carotid system (see VAN VALEN 1966:9-10; SZALAY 1975: 94-95), and is still an important collateral channel between the internal and external carotids in some mammals (see DE LA TORRE and NETSKY 1960).

At least in _Homo_, the artery of the pterygoid canal represents a persistent remnant of the primitive mandibular artery (first aortic arch). It is initially connected to the developing internal carotid, but later it is taken over by the (internal) maxillary artery of the external carotid. In most adult humans, it appears as a branch of the third or pterygopalatine division of the maxillary artery and is distributed to the pharynx and the auditory tube. Occasionally, the initial embryonic connexion will remain and the artery will arise instead from the intrapetrous portion of the internal carotid. (See PADGET 1948.)

The connexion with the internal carotid, which may well be primitive for mammals, is found in some lipotyphlans (e.g., _Erinaceus europaeus_). (See fig. I-4.)

AUDITORY or OTIC CAPSULE

"...is divisible into two portions. One is postero-dorsal in position and lodges the utricle and semicircular canals, forming the canalicular part [pars canalicularis] of the auditory capsule. The other is anteroventral in position, and accommodates the ductus cochlearis of the saccule, forming the cochlear capsule [pars cochlearis]" (DE BEER 1929:416).

AUDITORY OSSICLES

The malleus, incus and stapes. The malleus and incus derive from the material of both the first and second visceral bars, while the stapes derives from the second visceral bar (crura and head) and the material of the otic capsule (footplate or base). In addition, the anterior process of the malleus partly derives from an independent element, the gonial (q.v.). (See PEARSON and JACOBSON 1967:16-42.)

AUDITORY REGION

As used here, a locative term (such as "face", "valut", "jaws") for the part of the basicranium which contains the vestibulocochlear organ and the elements which enclose or lie immediately adjacent to it. More specifically, it includes the petrosal and the contiguous parts of the bones or cartilages which contact or lie near the petrosal

(usually, the squamosal, alisphenoid, basisphenoid, exoccipital, basioccipital, proximal part of the hyoid apperatus [Reichert's cartilage], ectotympanic, cartilage of the auditory tube, incus, stapes, malleus gonial, Meckel's cartilage, pterygoid and, among the inconstant elements, the entotympanic[s], element of Spence and of Paaw).

AUDITORY TUBE
(TUBA AUDITIVA, EUSTACHIAN TUBE, PHARYNOGOTYMPANIC TUBE)

The channel of communication between the tympanic cavity (cavum tympani) and the pharynx. The tube is lined by a mucous membrane which is continuous with that of the tympanic cavity at one end (tympanic ostium), and with that of the nasopharynx at the other (pharyngeal ostium).

The endoderm of the primitive pharynx forms an endodermal pouch by pressing outward toward the ectoderm at the site of the corresponding branchial groove. The groove, situated between the first (mandibular) and second (hyoid) arches and supported, respectively, by Meckel's and Reichert's cartilages, becomes (in part) the elongate auditory tube. (See ANSON and DONALDSON 1973:21, 173.)

AURICLE
(AURICULA, PINNA)

The outer part of the external ear. (ANSON and DONALDSON 1973:30.)

AURICULAR CARTILAGE
(CARTILAGO AURICULAE, CARTILAGE OF THE PINNA)

The elastic cartilage of complicated shape which forms the essential support of the external ear. It is a derivative of the mesoderm of the first branchial arch. (ANSON and DONALDSON 1973:18.)

Although the anular cartilage (or cartilage of the external acoustic meatus) forms separately and is not part of the auricular cartilage per se (see GETTY 1964:850), no attempt is made to distinguish the two in the figures.

AURICULAR RAMUS OF THE VAGUS NERVE
(RAMUS AURICULARIS N. VAGI, N. OF ARNOLD)

The nerve, containing somatic afferent fibers, which is released by the proximal (or jugular) ganglion of the vagus in the posterior lacerate foramen. It runs laterally across the mastoid region to the site of the stylomastoid foramen, where it joins or distributes filaments to the facial nerve. The nerve continues onwards to ramify in the integument of the external ear. (See SISSON 1938:826.)

See also MASTOID CANALICULUS.

BASAL PLATE

See CENTRAL STEM.

BASICAPSULAR FENESTRA
(BASICOCHLEAR FISSURE)

"...a space included between the ventromedial edge of the auditory capsule and the lateral edge of the parachordal cartilage [basal plate]" (DE BEER 1937:399). It is bounded by the anterior and posterior basicapsular commissures (if present).

In some cases (e.g., most soricomorphs; MCDOWELL 1958:202), this fenestra is not completely obliterated in the adult, which results in the basicranial exposure of part of the inferior petrosal sinus (q.v.).

BASILAR ARTERY
(A. BASILARIS)

So named from its position at the base of the cranial cavity. The artery is formed by the junction of the two vertebral arteries, which are in turn branches of the subclavian. Anteriorly, the basilar artery divides into the two posterior cerebral arteries, which communicate with the circulus arteriosus (q.v.). (JOHNSTON _et al_. 1958:769.)

BASISPHENOID BONE
(OS BASISPHENOIDALE)

One of the endochondral bones of the basicranium. It arises from paired centers in the cartilage of the central stem which become fused together and with another pair of ossification centers which arise subsequently in the processus alaris. The latter, or alar, centers extend backwards in the alicochlear commissures thus giving rise to the lingulae sphenoidales (conditions in _Homo_; DE BEER 1937: 370.)

The basisphenoid eventually meets the alisphenoid as they expand towards each other in the degenerating processus alaris. In the forms considered here, their fusion is complete and no suture separates them in the adult. Other fusions of relevance here include those with the posterior part of the pterygoid bone (usually early) and with the basioccipital at the site of the basioccipital-basisphenoidal synchondrosis (usually late, sometimes never completed).

BRANCHIAL ARCHES
(VISCERAL ARCHES, PHARYNGEAL ARCHES)

The six pairs of mesodermal masses between the branchial pouches and lateral to the pharynx of all vertebrate embryos. Each arch is

bounded by the endoderm on the pharyngeal side and the ectoderm on the outside. (RUCH 1971:349.)

The mesoderm of each arch is pluripotential, and, in addition to certain other structures, typically gives rise to an aortic arch, a skeletal element, and muscles (true of the first three arches, which are the only ones of interest here). The skeletogenic mesoderm of an arch is here separately denoted as a visceral bar (q.v.). Derivatives of the first three arches and their associated ecto- and endoderm are listed in Table 1-2.

BRANCHIAL CLEFTS
(VISCERAL CLEFTS, GROOVES)

The set of furrows (usually only three or four prominent ones in mammals) which externally bound the (first three or four) branchial arches. They are produced by the invagination of the ectoderm, and either meet or come into close relation with the corresponding branchial pouches leading from the primitive pharynx. (See BAXTER 1953:206-218.)

In mammals, all except the first cleft (located between the first and second branchial arches), which helps form the external acoustic meatus, normally disappear. (DAVIES 1967:147.)

BRANCHIAL POUCHES
(VISCERAL POUCHES, PHARYNGEAL POUCHES)

The set of indentations (usually five in mammals) of the primitive pharynx, produced by the evagination of its endoderm, which internally bound the branchial arches. (See BAXTER 1953:206-218.)

The tympanic cavity and auditory tube are derived from the first and possibly the second branchial pouches. (BAST and ANSON 1949:306-307.)

CANALICULUS FOR THE CHORDA TYMPANI
(CANALICULUS CHORDAE TYMPANI)

See CHORDA TYMPANI.

CARTILAGE OF THE AUDITORY TUBE
(CARTILAGO TUBAE AUDITIVAE)

The channelled, elongated piece of elastic cartilage which conducts the auditory tube towards the tympanic cavity. It often appears crook-or staff-shaped in cross-section. Of uncertain derivation.

CAUDAL <u>CHORDAFORTSATZ</u>

The bony or cartilaginous process which conducts the chorda tympani from its point of entry into the tympanic cavity towards the

malleus. It may develop from the ectotympanic, petrosal, or Reichert's cartilage, or it may form independently and later fuse to one or another of these elements. (See BONDY 1907:400-401.)

A Chordafortsatz which forms independently is distinguished as an element of Spence (q.v.).

CAUDAL ENTOTYMPANIC

An entotympanic which arises in the rear part of the ventral wall of the middle ear, often in proximity to Reichert's cartilage.

See ENTOTYMPANIC(S).

CAUDAL TYMPANIC PROCESS OF THE PETROSAL
(PROCESSUS TYMPANICUS PETROSI CAUDALIS)

As used here, any tympanic process which arises primarily from the ventral surface of the mastoid region of pars canalicularis.

It usually makes its first appearance as a cartilaginous ridge which grows outwards from, or is closely related to, the walls of the apertura fossulae fenestrae cochleae. In some cases (lemurs, lorises), the posterior continuation of the crista parotica is involved in its production as well.

In the forms considered here, it apparently never has its own center of ossification, but ossifies in continuity with the rest of the petrosal.

See PETROSAL PLATE.

CAVERNOUS SINUS

The large dural sinus, situated on either side of the sella turcica, through which the promontorial (or cerebral carotid) artery passes on its way to the circulus arteriosus. (See JOHNSTON et al., 1958:850.)

CAVUM SUPRACOCHLEARE

The space on the dorsal (cerebral) surface of the auditory capsule which houses the geniculate ganglion of the facial nerve. In the fetus it is bounded by the suprafacial commissures. The greater petrosal nerve and filaments destined for the tympanic plexus and the lesser petrosal nerve are given off by the geniculate in the cavum supracochleare. (See DE BEER 1937:430.)

In the adult, the cavum is recessed within the internal acoustic meatus. However, bone does not completely cover this space, for it remains open anteriorly at the hiatus of the facial canal (q.v.).

CAVUM TYMPANI

As used here, the sac bounded by mucous membrane which fills (in the adult) the (presumptive) tympanic cavity.

See TYMPANIC CAVITY and section 1.4.1.

CENTRAL STEM

In older embryos and fetuses, the bar or plate of fused cartilages which extends from the tip of the nose to the foramen magnum. It arises from three sources: the trabecular plate (or cartilago trabecularis, forming the nasal septum), the hypophyseal plate (or cartilago hypophysealis, surrounding the hypophyseal stalk), and the basal plate (or cartilago parachordalis, through which the notochord passes). In the prenatal stages relevant to this study, the three are more or less indistinguishably fused and will be collectively referred to as the central stem. (See ROUX 1947:175-176.)

Ossifications of interest here whose centers appear in the central stem or its outgrowths are the basisphenoid (initially in the hypophyseal plate), the basioccipital (initially in the posterior part of the basal plate), and the exoccipitals (initially in the occipital arches or cartilago occipitalis, which usually chondrify from the posterolateral angles of the basal plate). (See STARCK 1967:438.)

CHORDA TYMPANI

The mixed nerve released by the facial nerve beneath the stylomastoid foramen (see fig. I-4). It passes into the middle ear between the posterior crus of the ectotympanic and (usually) the squamosal; its foramen of entry may be well-defined and bony, in which case a canaliculus chordae tympani may be identified. Or, it may simply pass through the fibrous tissue related to the pars flaccida of the tympanic membrane, which fills the gap between the ectotympanic and the squamosal.

It passes around the medial surface of the malleus in close relation to the area of insertion of the tensor tympani, then runs alone the malleolar sulcus of the ectotympanic in company with the gonial (which it often perforates). The nerve emerges from the tympanic cavity through the Glaserian fissure.

Most of its fibers are afferent from the mucous membrane of the anterior two-thirds of the tongue. It also contains secretomotor fibers destined for the submandibular ganglion. (See DAVIES and DAVIES 1962:1138.)

CIRCULUS ARTERIOSUS
(CIRCLE OF WILLIS)

"...formed at the interpeduncular space of the base of the brain by the union of the anterior cerebral arteries in front, by the diverging posterior cerebral arteries behind, and is completed laterally

by the junction of the latter with the posterior communicating arteries and by the internal carotid [i.e., promontorial branch of the internal carotid]". (SISSON 1938:653.)

COCHLEAR CANALICULUS
(CANALICULUS COCHLEAE)

The small canal which establishes communication between the scala tympani and the subarachnoid space, and which transmits the perilymphatic duct. Its intracranial aperture lies directly behind and below the internal acoustic meatus, and is sometimes visible from the ventral aspect by looking through the posterior lacerate foramen. (See ANSON and DONALDSON 1973:187.)

In the NA, 'aqueductus cochleae' is considered to be an official alternative for the perilymphatic duct. However,it should be noted that the 'aqueductus cochleae' of older works almost always refers to the cochlear canaliculus.

CRISTA PAROTICA

In mammalian fetuses the crista parotica has the form of a downward and backward sloping ledge on the lateral side of the auditory capsule which accentuates the prominence of the lateral semicircular canal and forms the lateral wall of the (cartilaginous) facial sulcus. The tegmen tympani develops as an anteriorly-directed projection on the middle portion of the crista parotica, while Reichert's cartilage normally fuses with its lateral portion. (DE BEER 1937:405.)

The crista parotica is typically continued backwards for a distance behind the place where it fuses with Reichert's cartilage. This part of the crista parotica, which is sometimes involved in the production of a part of the caudal tympanic process of the petrosal, is here separately denoted as the "posterior continuation of the crista parotica". In the adult, the (now ossified) posterior continuation is often visible as a low ridge behind the root of the tympanohyal (in cases where it is not incorporated into a true caudal tympanic process of the petrosal).

CRISTA TYMPANICA

The low semicircular ridge (actually the dorsal margin of the ectotympanic) which borders the tympanic sulcus. (BONDY 1907:300.)

DEEP PETROSAL NERVE
(N. PETROSUS PROFUNDUS)

This nerve may be thought of as the continuation of the lateral branch (or plexus) of the internal carotid nerve to the lacrimal gland and nasal mucosa. Here, it will be considered to start where the lateral

of the internal carotid nerve comes into close relation with the greater petrosal nerve on the roof of the tympanic cavity, beneath the piriform fenestra (see fig. I-4). The deep petrosal and greater petrosal nerves continue forwards as the nerves of the pterygoid canal (q.v.). (See DAVIES 1967:1250.)

DIVERTICULUM

As used here, a general term for any well-marked fossa or recess on the walls of the middle ear, other than those with common names (e.g., epitympanic recess, fossula fenestrae cochleae, fossa for the tensor tympani).

ECTOTYMPANIC
(AN[N]ULUS TYMPANICUS, TYMPANIC RING, TYMPANIC BONE)

The intramembranous bone which supports the tympanic membrane. (MCDOWELL 1958:129.)

Embryonically, it always has the form of a horseshoe, being incomplete dorsolaterally at the tympanic notch. It may be said to consist of two legs, termed here the anterior and posterior crura.

The ectotympanic develops within connective tissue surrounding the developing tympanic membrane, sometimes from multiple centers (e.g., Homo). (See RICHANY, BAST and ANSON 1975:9.)

ELEMENT OF PAAW (or PAAUW)

A small piece of bone or cartilage which is found in the tendon of the stapedius muscle in some mammals. (HENSON 1961:163.)

It may be a vestige of the extrastapes (extracolumella) of reptiles (VAN DER KLAAUW 1923; DE BEER 1937:441), or the functional equivalent of a sesamoid bone (MCCRADY 1938). However, whatever its evolutionary roots, in modern mammals it must be considered an ontogenetic derivative of the interhyal, the transitory bridge of blasteme which initially connects the stapes primordium to the rest of the second visceral (hyoid) bar and which becomes the tendon of the stapedius muscle (case in Homo). (See PEARSON and JACOBSON 1967:26.)

Spelling (Paaw rather than the usual Paauw) is that recommended by HINCHCLIFFE and PYE (1969:279).

ELEMENT OF SPENCE

An inconstant skeletal element which lies in the rear of the tympanic cavity, immediately in front of the origin of the chorda tympani from the facial nerve, and a short distance from the anterior aspect of Reichert's cartilage. When large, it extends medially to the position of the malleus, thereby forming a supporting strut for the chorda tympani in this part of its route. In many cases it apparently

remains partly or wholly cartilaginous, while in others it ossifies. It may secondarily fuse to other elements (e.g., squamosal, ectotympanic). (VAN DER KLAAUW 1923:622.)

The element of Spence, like the element of Paaw (q.v.), may represent a vestige of the reptilian extrastapes (extracolumella). However, the relationship of the element of Spence to the chorda tympani and malleus suggests that in the modern mammal the first-named structure is a derivative of the so-called "interbranchial bridge" which connects the first (mandibular) to the second (hyoid) visceral bar, and which gives rise to part of the malleus and incus (case in Homo). (See PEARSON and JACOBSON 1967:20.)

ENTOGLENOID PROCESS OF THE SQUAMOSAL

A descending part of the squamosal which is of interest here because it may, in some mammals, incidentally bound the anterolateral part of the tympanic cavity. In some mammals it functionally replaces the processus postglenoideus as the articular eminence for the mandible. See fig. I-2. (See MCDOWELL 1958:123.)

ENTOTYMPANIC(S)
(OS ENTOTYMPANICUM, TUBOTYMPANIC, ENDOTYMPANIC, METATYMPANIC)

"Under this name we take together all the skeletal elements, bony or cartilaginous, that lie in the ventral wall of the tympanic cavity and are ontogenetically primarily independent of the other elements in the auditory bulla, except perhaps the tympanohyal and the cartilage of the Eustachian tube" (VAN DER KLAAUW 1931:266).

Sometimes two (or even more) separate entotympanics can be distinguished, in which case rostral and caudal elements are identified.

See ROSTRAL ENTOTYMPANIC, CAUDAL ENTOTYMPANIC.

EPITYMPANIC CREST

A term coined here to refer to the incomplete septum which borders the anterior margin of the epitympanic recess in lorises and lemurs (and perhaps other mammals as well). The stapedial artery either penetrates or travels in a bony canal along this crest; the crest is not a Chordafortsatz (q.v.) and has no relationship with the chorda tympani.

EPITYMPANIC RECESS
(RECESSUS EPITYMPANICUS, ATTICUS TYMPANICUS)

The epitympanic recess is a dorsal extension of the tympanic cavity which lies above the upper level of the tympanic membrane. Contained within it are those parts of the malleus and incus which articulate to form the incudomalleolar articulation. (HENSON 1961:156.)

"The recessus epitympanicus is covered on the medial side by the tegmen tympani of the periotic, which is also a neomorph in mammals, also by the squamosal, while the lateral part is very differently developed" (VAN DER KLAAUW 1931:73).

EPITYMPANIC WING

A general term used for any bony or cartilaginous horizontal outgrowth of a basicranial bone which contributes to the roof of the middle ear.

See TYMPANIC PROCESS and fig. I-3.

EPITYMPANIC WING OF THE SPHENOID

On of the epitympanic wings commonly found in the anterior part of the roof of the tympanic cavity. Often, both the alisphenoid and the basisphenoid participate in this wing, but their separate contributions cannot be made out in the adult because of fusion.

See fig. I-3.

EPITYMPANIC WING OF THE PETROSAL

A term coined here to refer to the (usually) small anterodorsal outgrowth of the pars cochlearis which forms part of the roof of the tympanic cavity in some mammals. It is originally independent of the tegmen tympani (q.v.), although the two may fuse together later in ontogeny. This epitympanic wing is often, but not always, associated with a large rostral tympanic process of the petrosal.

See fig. I-3.

EPITYMPANIC WING OF THE SQUAMOSAL

The medial extension of the squamosal which participates in the roof of the tympanic cavity in the area of the epitympanic recess. Very small or deficient in some forms.

See fig. I-3.

EXTERNAL ACOUSTIC MEATUS
(MEATUS ACUSTICUS EXTERNUS)

In the living mammal, the channel which extends from the bottom of the auricle to the tympanic membrane. It consists of a cartilaginous portion (formed by the auricular cartilage) and an osseous portion (usually formed by the ectotympanic, although sometimes by the petrosal or entotympanic). Covering both these portions and lining the entire lumen is the skin of the external acoustic meatus (also known as the membranous meatus).

There is considerable variation among mammals in the degree to which the osseous portion is built outwards. (See VAN KAMPEN 1905: 358-359.)

EXTERNAL EAR

The auricle and external acoustic meatus.

FACIAL CANAL
(CANALIS FACIALIS)

See FACIAL SULCUS.

FACIAL (VII) NERVE
(N. FACIALIS)

The nerve of the second (hyoid) visceral arch. From its superficial origin at the lateral part of the corpus trapezoideum to its foramen of exit from the cranium (stylomastoid foramen), it follows a tortuous course through the auditory capsule.

In the fetal mammal, it passes into the presumptive tympanic cavity by means of the foramen faciale (q.v.) after traversing the cavum supracochleare, entering slightly above and in front of the apertura fenestrae vestibuli. It then bends posteriorly and ventrally on the lateral wall of pars canalicularis (labyrinthine wall), beneath the root of the tegmen tympani. It leaves the middle ear by passing around the posterior face of Reichert's cartilage, through the foramen stylomastoideum primitivum (q.v.). (See STARCK 1965:429.)

See fig. I-4.

FACIAL SULCUS (or CANAL)
(SULCUS FACIALIS, CANALIS FACIALIS)

The sulcus is the groove which accommodates the facial nerve in its passage through the tympanic cavity. Usually, it can be traced from the foramen faciale to the stylomastoid foramen. (See DE BEER 1929:418.)

The facial nerve is never enclosed in a complete cartilaginous tube during ontogeny, although in many species periosteal outgrowths of the ossifying petrosal may eventually enclose the nerve in a canal (facial canal, aqueduct of Fallopius). (See STARCK 1965:428.)

FENESTRA COCHLEAE
(COCHLEAR FENESTRA, FENESTRA ROTUNDA, ROUND WINDOW)

"The cochlear fenestra...lies in the anterosuperior wall of the fossula. Its bony margin is formed posteriorly by part of the cochlear

capsule, inferiorly by bone developed in late fetal life from a related bar of cartilage [processus recessus], anteriorly by part of the inner portion of the bony promontory, and superiorly by the two bony spiral laminas....In a macerated specimen the window opens into the cochlea; in the fresh state it is closed by the secondary tympanic membrane" (RICHANY, ANSON and BAST 1975:95-96).

See FOSSULA FENESTRAE COCHLEAE.

FENESTRA VESTIBULI
(FENESTRA OVALIS, OVAL WINDOW)

See APERTURA FENESTRAE VESTIBULI.

FIBROUS MEMBRANE OF THE TYMPANIC CAVITY

The connective-tissue membrane which ventrally encloses, and forms the original floor of, the presumptive tympanic cavity.

See section 1.4.1.

FISSURA METOTICA

An aperture of the chondrocranium situated between the basal plate medially, the occipital posteriorly, and the auditory capsule laterally. It is closed anteriorly by the fusion of the medial wall of the auditory capsule with the edge of the basal plate. (DE BEER 1929:414.)

The internal jugular vein and the IX, X and XI cranial nerves pass through the fissura metotica to their various destinations. In later ontogeny, the fissura is often subdivided by cartilage or bone into a jugular foramen and a foramen for the cranial nerves.

See POSTERIOR LACERATE FORAMEN.

FORAMEN CAROTICUM PRIMITIVUM

Restricted here to the foramen of the chondrocranium through which the promontorial artery enters the cranial cavity. This foramen has certain constant relations to other basicranial structures:

"...the processus alaris (basitrabecular process) develops just in front of where the carotid enters the skull. Behind the carotid is the cochlear part of the auditory capsule, but the carotid is still free laterally and not enclosed until the alicochlear commissure develops, joining the ala temporalis with the pars cochlearis. This encloses the carotid in a foramen caroticum..." (DE BEER 1926:342).

The alicochlear commissure does not always develop, and for cases where this occurs an incisura carotica primitiva is distinguished. Later in ontogeny, the cartilaginous foramen caroticum primitivum becomes the bony anterior carotid foramen (q.v.) as a result of the growth of surrounding bones.

FORAMEN FACIALE
(APERTURA TYMPANICA CANALIS FACIALIS)

As used here, the foramen through which the facial nerve enters the middle ear from the cavum supracochleare. (See DE BEER 1929:418.)

This foramen is sometimes (and incorrectly) called the foramen stylomastoideum primitivum (q.v.).

FORAMEN FOR THE GREATER PETROSAL NERVE

A remnant of the piriform fenestra (in species in which the fenestra is obliterated), by means of which the greater petrosal nerve enters the tympanic cavity.

On the dorsal surface of the auditory capsule, this foramen is joined to the hiatus of the facial canal (q.v.) by means of a short furrow (the sulcus for the greater petrosal nerve).

FORAMEN FOR THE LESSER PETROSAL NERVE
(CANALICULUS INNOMINATUS)

Used in those cases where the lesser petrosal nerve passes through an aperture in the tympanic process of the alisphenoid which is separate from the foramen for the ramus inferior of the stapedial artery (q.v.).

FORAMEN FOR THE RAMUS INFERIOR (OF THE STAPEDIAL ARTERY)

The foramen (or notch) in the tympanic process of the alisphenoid, adjacent to the foramen ovale, which transmits the ramus inferior. (GREGORY 1920:172.)

This foramen often transmits the lesser petrosal nerve and small veins as well.

FORAMEN FOR THE RAMUS SUPERIOR (OF THE STAPEDIAL ARTERY)

The foramen in the roof of the tympanic cavity through which the ramus superior and accompanying veins escape into the cranial cavity. It usually lies in the tegmen tympani, or between the latter and the epitympanic wings of the squamosal and the sphenoid (i.e., in part of the piriform fenestra).

This term is used in preference to foramen spinosum, the aperture through which the middle meningeal artery enters the cranial cavity in Homo. Although the human middle meningeal is partly derived from the embryonic stapedial system, its development in man and certain other higher primates is so specialized (see BUGGE 1974) that it seems better to employ a generalized term for describing conditions in other mammals.

FORAMEN OVALE

"The foramen ovale always looks toward the inner face of the mandible, since it gives exit to the mandibular branch of the trigeminal nerve" (GREGORY 1910:429.)

The foramen ovale usually lies entirely within the alisphenoid.

FORAMEN STYLOMASTOIDEUM DEFINITIVUM

See STYLOMASTOID FORAMEN.

FORAMEN STYLOMASTOIDEUM PRIMITIVUM

See STYLOMASTOID FORAMEN.

FOSSA FOR THE STAPEDIUS MUSCLE
(FOSSA MUSCULARIS MINOR)

The shallow depression which accommodates the origin of the stapedius muscle. It lies posteromedial to the stylomastoid foramen and tympanohyal and posterolateral to the apertura fossulae fenestrae cochleae. (MACINTYRE 1972:282-282.)

FOSSA FOR THE TENSOR TYMPANI MUSCLE
(FOSSA MUSCULARIS MAJOR)

The shallow depression which accommodates the belly and a small part of the origin of the tensor tympani. It lies on the upper part of pars cochlearis, or on the latter and the epitympanic wing of the petrosal.

FOSSA INCUDIS

"...a small depression in the lower and posterior part of the epitympanic recess; it lodges the short process of the incus, which is fixed to the fossa by ligamentous fibers" (DAVIES 1967:1322).

FOSSULA FENESTRAE COCHLEAE
(FOSSULA FENESTRAE ROTUNDAE, PELVIS ROTUNDA)

The funnel-shaped niche in the auditory capsule which contains the fenestra cochlea and hides it from view.

"The fossula...is an irregularly prismatic recess, with rounded angles, which extends from a point near the bottom of the middle ear upward and inward beneath the arch of the first turn of the cochlea. One surface of the prism-shaped space is directed downward and represents

the tympanic aditus [apertura] of the fossula. Much of the rim of the opening is formed by the overhanging ledge of the promontory produced by the arch of the first coil of the cochlea" (RICHANY, ANSON and BAST 1975:92).

See APERTURA FOSSULAE FENESTRAE COCHLEAE, FENESTRA COCHLEAE.

GLASERIAN FISSURE
(FISSURA GLASERI, FISSURA PETROTYMPANICA)

"...is at first the aperture for the cartilage of Meckel, which disappears later in the development. Later on we find the chorda tympani in it and often also the ramus inferior of the stapedial artery.

"The fissura Glaseri lies between: (a) the sulcus malleolaris of the tympanic...and (b) the periotic, or (c) the margo fissurae of the squamosal...; it lies alongside the tegmen tympani" (VAN DER KLAAUW 1931:164).

The entotympanic can also be involved, as in _Tupaia_.

Although an eponymous name, "Glaserian fissure" is preferable to the "fissura petrotympanica" of the NA, for the latter term is not descriptive of conditions in many non-human forms.

GLOSSOPHARYNGEAL (IX) NERVE
(N. GLOSSOPHARYNGEUS)

The cranial nerve issuing from the posterior lacerate foramen (see fig. I-4) which supplies motor fibers to muscles of the pharynx and the parotid gland, and sensory fibers to the pharynx, tonsil and posterior part of the tongue. (JOHNSTON _et al_., 1958:1127.)

GONIAL
(GONIALE, PREARTICULAR)

An intramembranous ossification of mammals which fuses with the malleus (and occasionally the ectotympanic as well) and which forms part of the processus anterior (gracilis, Folii of adult _Homo_). It is usually perforated or notched by the chorda tympani. (DE BEER 1937:441.)

GREATER PETROSAL NERVE
(N. PETROSUS MAJOR, GREATER SUPERFICIAL PETROSAL N., PALATINE BRANCH OF THE FACIAL N.)

A branch of communication of the facial nerve (geniculate ganglion to pterygopalatine ganglion) which consists chiefly of sensory branches which are distributed to the mucous membrane of the soft palate; but it also contains the preganglionic fibers which form the motor root of pterygopalatine ganglion.

From its origin at the geniculate ganglion the nerve passes through the hiatus of the facial canal, runs along the cerebral surface

of the auditory capsule beneath the trigeminal ganglion, and meets the deep petrosal nerve by travelling through the piriform fenestra (or its own foramen) into the middle ear. The greater and deep petrosal nerves travel in close relation thereafter, as the nerves of the pterygoid canal (fig. I-4). (See DAVIES 1967:1160.)

HIATUS OF THE FACIAL CANAL
(HIATUS CANALIS FACIALIS, HIATUS FALLOPII)

The foramen on the anterodorsal surface of the petrosal, leading from the cavum supracochleare, through which escape the greater petrosal nerve and filaments destined for the tympanic plexus and lesser petrosal nerve. (See ANSON and DONALDSON 1973:5.)

HYPOGLOSSAL FORAMEN or CANAL

The foramen in the occipital for the hypoglossal (XII) nerve. The names "condylar foramen" and "condyloid foramen" are not used here, because of the possible confusion with the condyloid canal for a vein. (MCDOWELL 1958:125.)

HYPOTYMPANIC SINUS
(SINUS HYPOTYMPANICUS)

"The hypotympanic sinus covers a part of the tympanic cavity that contains none of its principal elements, including the auditory ossicles and the fenestrae in the periotic. It is formed when the ventral wall loses its flatness and becomes inflated on the medial or caudal side" (VAN DER KLAAUW 1931:19).

INFERIOR PETROSAL SINUS
(SINUS PETROSUS INFERIOR)

A vein of the dura mater, draining from the cavernous sinus to the internal jugular. (DAVIES 1967:897.)

In man, its route is entirely intracranial and it meets the internal jugular within the jugular foramen. In some mammals, however, the distal section of the sinus is partly exposed between the petrosal and the basioccipital, and the place where it meets the internal jugular may be extracranial (i.e., beneath rather than within the jugular foramen or posterior lacerate foramen). This exposure is due to the failure of the basicapsular fenestra to close during the ossification of the cranium.

INTERNAL CAROTID ARTERY
(A. CAROTIS INTERNA, ENTOCAROTID A.)

A division of the common carotid artery which (usually) provides the greater part of the arterial supply of the anterior part of the brain, the eye and its appendages. However, in numerous mammals this vessel may be partly or wholly obliterated during ontogeny. (See BUGGE 1974.)

The internal carotid is considered here to terminate at the point where it bifurcates into the stapedial and promontorial arteries (see fig. I-4).

INTERNAL CAROTID NERVE
(N. CAROTICUS INTERNUS)

This nerve originates from the cranial (or superior) cervical ganglion of the autonomic nervous system and contains postganglionic fibers. It ascends the internal carotid artery and enters the posterior carotid foramen in company with the latter vessel. Just before or after it passes through the foramen, the nerve divides,usually into a lateral and a medial branch. Both branches then follow the promontorial artery, after the bifurcation of the internal carotid artery, towards the anterior pole of the promontory (see fig. I-4).

The internal carotid nerve communicates with a variety of other nerves by means of the plexus it forms around the internal carotid (i.e., promontorial) artery. One such branch is the deep petrosal (q.v.), which mainly arises from the lateral branch. In most cases, the majority of the fibers of the medial branch follow the promontorial artery through the anterior carotid foramen, where they form the cavernous plexus in the vicinity of the cavernous sinus and hypophysis.

Within the tympanic cavity the internal carotid nerve usually communicates, by means of fine filaments, with the tympanic branch of the glossopharyngeal (q.v.). (See DAVIES 1967:1249-1259.)

INTERNAL EAR

The internal ear consists of two parts: (a) the bony labyrinth, a series of cavities within the petrosal (vestibule, semicircular canals, and cochlea), and (b) the membranous labyrinth, a series of communicating membranous sacs and ducts (utricle and saccule, semicircular ducts, and duct of the cochlea), contained within the bony cavities. (DAVIES and DAVIES 1962:1302.)

JUGULAR FORAMEN
(FORAMEN JUGULARE)

The foramen of the osteocranium which provides passage for the internal jugular vein. It is not always found, for the fissura metotica (q.v.) is not always subdivided during the development of the skull.

LAMINA ALARIS

"Laterally each occipital arch is produced to form the lamina alaris, which extends behind and under the auditory capsule and ends ventrally in a well-developed paracondylar process for the rectus capitis lateralis" (DE BEER 1937:309).

LESSER PETROSAL NERVE
(N. PETROSUS MINOR, LESSER SUPERFICIAL PETROSAL N.)

The nerve formed by the union of filaments from the tympanic nerve (through the tympanic plexus) and a small branch (ramus anastomicus cum plexo tympanico) from the geniculate ganglion, which runs to the otic ganglion (see fig. I-4). The lesser petrosal nerve may be looked upon as the continuation of the tympanic nerve of the glossopharyngeal (q.v.). Contains secretomotor fibers for the parotid gland. (See DAVIES 1967:1328.)

LINEA SEMICIRCULARIS

The curved ridge of bone on the internal aspect of the lateral bullar wall in lemurs and tree shrews, the arc of which closely conforms to that of the ectotympanic.

MALLEOLAR SULCUS
(SULCUS MALLEOLARIS)

Shallow trough on the apex of the anterior crus of the ectotympanic which communicates with the Glaserian fissure, and along which the chorda tympani, gonial and Meckel's cartilage travel. (See VAN DER KLAAUW 1931:164.)

MANDIBULAR FOSSA
(FOSSA MANDIBULARIS: GLENOID FOSSA)

The concavity on the squamosal which lodges the head of the mandible. (DAVIES 1967:323.)

MASTOID CANALICULUS
(CANALICULUS MASTOIDEUS, OSTIUM INTROITUM)

The small foramen in the petrosal by means of which the auricular branch of the vagus enters the substance of the petrosal bone in some mammals. (See ANSON and DONALDSON 1973:7.)

MASTOID CAVITY

As used here, any distinct cavity which develops as a posterior inflation of the epitympanic recess and invades the bone forming the lateral wall of pars canalicularis (in some forms, the squamosal is invaded as well). In most cases, the cavity itself appears to correspond to the antrum, although the accessory spaces and cellules which may in turn develop from the antrum in other mammals do not always have counterparts in Homo, and vice versa.

MASTOID REGION

"...the posterior portion of the petrosal bone, essentially that portion of the bone posterior to a line joining the foramen stylomastoideum primitivum and foramen lacerum posterius" (MCDOWELL 1958:126).

The term "mastoid process" is avoided here since it is used in a great variety of senses. Where it is necessary to refer to an enlargment on the lateral part of the mastoid region, the neutral term "mastoid eminence" will be used.

MECKEL's CARTILAGE
(DORSAL CARTILAGE OF THE FIRST BRANCHIAL ARCH)

The well-developed bar of cartilage which forms from the first visceral (mandibular) bar. Its ventral end is involved in the formation of the mandible, while its dorsal end is initially continuous with the primordia of the malleus and the incus. Its intermediate part disappears or becomes a ligament. (See BAXTER 1953:289.)

Although an eponymous name, it is the only one with any currency in comparative embryology and is listed (but presumably as an unofficial alternative) in the NE.

MEDIAL ACCESSORY CAVITY

As used here, the space developed within the substance of the petrosal plate in lorises as a consequence of pneumatic activity originating from the supracochlear and mastoid cavities (and ultimately the epitympanic recess).

Although other authors (e.g., SABAN 1963, 1964) have regarded the medial accessory cavity as a part of the hypotympanic sinus, this usage is avoided because it suggests that the space inflates from the tympanic cavity proper.

MEMBRANOUS MEATUS

See EXTERNAL ACOUSTIC MEATUS.

MEMBRANOUS VENTRAL WALL OF THE TYMPANIC CAVITY

The early condition of the ventral wall, transitory in most mammals, when it consists only of the fibrous membrane of the tympanic cavity (q.v.) and the ventral part of the ectotympanic.

MIDDLE EAR
(AURIS MEDIA)

"The middle ear includes the tympanic cavity (cavum tympani), the tympanic antrum (antrum mastoideum), and the auditory tube (tuba auditiva). These constitute a continuous, irregular, pneumatic chamber and passage, located through the greater part of its extent in the temporal bone. The centrally located tympanic cavity is shut off from the external ear by the tympanic membrane (membrana tympani), and from the chamber that forms the internal ear by the structures that occupy the cochlear and vestibular windows" (ANSON and DONALDSON 1973:164).

MIDDLE MENINGEAL ARTERY
(A. MENINGEA MEDIA)

A branch, or merely the continuation of, the ramus superior of the stapedial artery which lies within the dura mater of the cranial cavity. (MCDOWELL 1958:126.)

NERVES OF THE PTERYGOID CANAL
(NN. CANALIS PTERYGOIDEI, VIDIAN NERVES)

The greater and deep petrosal nerves, during their passage through the pterygoid canal (fig. I-4).

It is universally held in textbooks of anatomy that these two nerves actually unite to form the vidian nerve (nerve of the pterygoid canal). HIGBEE (1975:9), however, points out that union is quite improbable. The deep petrosal is a bundle of postganglionic fibers of the sympathetic system which extends from the cranial cervical ganglion to the nasal mucosa and lacrimal gland without interruption. The greater petrosal nerve is composed of preganglionic fibers of the parasympathetic system extending from the superior salivary nucleus to the pterygopalatine ganglion. An anastomosis of the fibers, which are functionally anatagonistic, is inconceivable.

It can be demonstrated that the greater and deep petrosal nerves are separated by a sheath of connective tissue during their passage through the pterygoid canal in Homo. However, this sheath was not identifiable in the material available for this study. Nonetheless, I think it is necessary to accept HIGBEE's claim that the fibers of the two nerves maintain their independence. For this reason, I have emended the 'nerve' of the NA to 'nerves'.

OTIC GANGLION
(G. OTICUM)

A cephalic parasympathetic ganglion, topographically associated with the mandibular division of the trigeminal and lying immediately beneath the foramen ovale. It receives roots from the glossopharyngeal and facial nerves via the lesser petrosal nerve. (DAVIES 1967:1169.)

PARS CANALICULARIS

See AUDITORY CAPSULE.

PARS COCHLEARIS

See AUDITORY CAPSULE.

PERILYMPHATIC DUCT
(DUCTUS PERILYMPHATICUS, PERIOTIC DUCT, AQUEDUCTUS COCHLEAE)

"...is not a true duct but a potential space containing an arachnoid type of connective tissue and fluid. It begins in the scala tympani, near the cochlear window, and terminates in a funnel-shaped aperture situated medial to the jugular fossa" (ANSON and DONALDSON 1973:187).

See COCHLEAR CANALICULUS.

PETROSAL
(OS PETROSUM, PERIOTIC, PETROMASTOID)

"The entire bone formed by ossification of the otic capsule and its various processes. Because in man the petrosal, squamosal, and tympanic bones are fused into one, it is usual in human anatomy to refer to this bone as the 'petrous portion of the temporal bone'" (MCDOWELL 1958:126).

PETRO-OCCIPITAL SINUS

The name given by SABAN (1963:96) to the vein draining from the cavernous sinus, through the anterior carotid foramen, to the internal jugular vein.

Among the mammals studied here, the complete vessel is found only in lorises and cheirogaleid lemurs. In other cases, it is either absent or represented only by small emissary veins draining to the pharyngeal venous plexus (rather than to the internal jugular).

PETROSAL PLATE
(BULLA TYMPANICA PETROSI, PETROSAL BULLA)

The lamella formed by the union of the rostral and caudal tympanic processes of the petrosal (qq.v.), which forms part or all of the bony ventral wall in certain mammals.

PETROSQUAMOUS SINUS

The dural sinus which passes through the postglenoid foramen in order to drain into the external jugular vein. Absent or vestigial in man, but very common in mammals generally. (See BATSON 1975:15.)

PIRIFORM FENESTRA
(PYRIFORM FENESTRA)

This term (here emended to conform to the spelling rules of the NA) was originally coined by MCDOWELL (1958:128) to apply to the large vacuity in the roof of the middle ear of certain lipotyphlans. Here, the term will be broadened in meaning to include the large gap, seen in all fetal and a few adult mammals, which lies between the anterior end of the auditory capsule and its outgrowths (epitympanic wing of the petrosal, tegmen tympani) on the one hand and the epitympanic outgrowths of the sphenoid and squamosal on the other (see fig. I-3).

It is important to understand the relations of the piriform fenestra to the foramen caroticum primitivum and the later anterior carotid foramen. In the fetal mammal, the piriform fenestra is not continuous with the foramen caroticum primitivum, for the two are separated by the alicochlear commissure (q.v.; lorises and a few other mammals are special exceptions, but they do not change the generality of this observation). Hence it follows that the piriform fenestra in the fetus never gives passage to the promontorial artery.

With the ossification of the cranium, the piriform fenestra experiences different fates in different species. In the adults of many mammals, the fenestra is largely closed over as a result of the growth of the epitympanic wings; in these instances, its original position will be indicated by sutures alone (petrosphenoid, medial petrosquamosal). In the adults of some mammals (e.g., many soricomorphs), however, the growth of the epitympanic wings is not so extensive and a membrane-covered deficiency of varying size and relations will remain. In such cases, the remaining part of the piriform fenestra and the anterior carotid foramen will appear to be continuous in macerated skulls. The large gap thus produced is often called the "middle lacerate foramen", but the lateral part of this foramen is obviously not involved in the passage of the promontorial artery and has nothing to do with the original foramen caroticum primitivum. For this reason, the term "middle lacerate foramen" is not employed here.

POSTERIOR BASICAPSULAR COMMISSURE
(BASIVESTIBULAR COMMISSURE)

The transitory, cartilaginous bridge which joins the postero-medial side of pars cochlearis to the basal plate of the central stem. It separates the basicapsular fenestra from the fissura metotica. Occasionally absent. (See STARCH 1967:444.)

POSTERIOR CAROTID FORAMEN

The foramen of ingress by means of which the internal carotid artery enters the posterior part of the middle ear.

"The posterior carotid foramen lies generally in the hinder part of the bulla, a little more on the medial side than the stylomastoid foramen. It is not always present, first, since there is not always a bulla, as in monotremes, in Sorex, Orycteropus, and others; secondly, since the ventral wall of the bulla is sometimes partly membranous" (VAN DER KLAAUS 1931:179).

In addition to the internal carotid artery, the foramen also transmits the internal carotid nerve, and, occasionally, other small vessels.

POSTERIOR CONTINUATION OF THE CRISTA PAROTICA.

See CRISTA PAROTICA.

POSTERIOR LACERATE FORAMEN
(FORAMEN LACERUM POSTERIUS)

The foramen in the rear part of the osteocranium which provides passage for the IX, X, and XI cranial nerves (and the internal jugular vein as well in forms which lack a separate jugular foramen). It is the successor of the fissura metotica of the chondrocranium (q.v.).

Although the term "middle lacerate foramen" is not used here (see PIRIFORM FENESTRA), the comparative "posterior" is retained in order to avoid confusion.

POSTGLENOID FORAMEN

The foramen situated behind the mandibular fossa which transmits the persistent petrosquamous sinus (q.v.).

POSTGLENOID PROCESS

Following MCDOWELL (1958:127), any kind of projection of the squamosal which receives the condyle of the mandible. However, in some forms the "true" postglenoid process (see PROCESSUS POSTGLENOIDEUS) has probably been functionally replaced by the entoglenoid process (q.v.).

POSTTYMPANIC PROCESS

A process formed by the squamosal which is related to the posterior margin of the external acoustic meatus. (See VAN KAMPEN 1905:343.)

PROCESSUS ALARIS
(PROCESSUS BASITRABECULARIS)

A laterally-projecting outgrowth which chondrifies from the hypophyseal plate of the central stem, and which communicates laterally with the alicochlear commissure and with the basal end of the ala temporalis. (See ROUX 1947:178.)

PROCESSUS POSTGLENOIDEUS

"Here used to mean a 'true postglenoid process' homologous with that of man. That is, a process of the squamosal on the zygomatic arch, near the juncture of the latter with the braincase, abutting against the posterior surface of the dentary condyle and attacking the latter from directly posterior. The process lies mainly or entirely dorsolateral to the Meckelian cartilage and chorda tympani and is anterior or anterolateral to the postglenoid foramen (when the latter is present)" (MCDOWELL 1958:127).

PROCESSUS RECESSUS

The cartilaginous process or bar which extends from the posteroventral surface of the pars cochlearis to the anteroventral surface of pars canalicularis and which provides the floor of the recessus scalae tympani. It helps to define medial and lateral apertures for the recessus, which become the cochlear canaliculus and fenestra cochleae in later ontogeny. (See DE BEER 1929; and FRICK 1952, 1954.)

The processus recessus becomes increasingly complex structurally as it develops and ossifies. From the vantage point of adult middle ear anatomy, its relations are most easily understood if it is remembered that it forms the medial wall of the apertura fossulae fenestrae cochleae (q.v.).

PROCESSUS STYLIFORMIS

"The processus styliformis is a process of the fore end of the auditory bulla and forms the prolongation of the bony Eustachian tube" (VAN DER KLAAUW 1931:133). The equivalent of the processus muscularis of veterinary anatomy (SISSON 1938:63), it gives purchase to the tensor and levator palati muscles.

PROMONTORIAL ARTERY
(A. PROMONTORII, PROMONTORY A., LATERAL INTERNAL CAROTID A.)

The medial of the two branches formed by the bifurcation of the internal carotid artery after it enters the middle ear, the other branch being the stapedial artery. From its origin, the promontorial artery traverses the ventral surface of the promontory, passes over the latter's anterior pole, and enters the cranial cavity in order to join the circulus arteriosus.

This artery may be considered to be the distal segment of, and is therefore often called, the internal carotid.

PROMONTORY
(PROMONTORIUM)

The rounded prominence within the middle ear formed by the projection outward of the first turn of the cochlea. (DAVIES 1967:1321.)

It corresponds to the major portion of the pars cochlearis, except, of course, for the latter's dorsal (cerebral) surface (which is not visible from the middle ear).

In the text, anterior and posterior poles of the promontory are distinguished. The former contains the swollen apex of the cupula cochleae, while the latter includes the region housing the fossula fenestrae cochleae.

PTERYGOID BONE
(OS PTERYGOIDEUM)

An independent, intramembranous ossification which fuses with the alisphenoid and basisphenoid. Its descending portion forms the medial pterygoid lamina, while its posterior end sometimes takes part in the construction of the tympanic process of the basisphenoid and adjacent incisure or groove for the auditory tube. (See DE BEER 1937:366.)

PTERYGOID CANAL
(CANALIS PTERYGOIDEUS, VIDIAN CANAL)

A canal of the osteocranium, usually passing along or through the site of fusion of the pterygoid and basisphenoid, which transmits the nerves of the pterygoid canal and occasionally an accompanying artery (artery of the pterygoid canal, q.v.). (See DE BEER 1937:314.)

The mere presence of a pterygoid canal in a dried skull or a fossil does not conclusively establish that the artery of the pterygoid canal was present, in the absence of other evidence. There is no way of determining in such cases whether the canal contained only nerves or the artery as well.

PTERYGOPALATINE GANGLION
(G. PTERYGOPALATINUM, SPHENOPALATINE G.)

The largest of the cephalic parasympathetic ganglia topographically associated with the trigeminal nerve. It is situated within the pterygopalatine fossa, close to the sphenopalatine foramen and in front of the anterior orifice of the pterygoid canal. (DAVIES 1967:1149-1150.)

See NERVES OF THE PTERYGOID CANAL.

RAMUS INFERIOR (OF THE STAPEDIAL ARTERY)

A branch of the (proximal) stapedial artery which runs across the anterior part of the roof of the tympanic cavity to enter the temporal fossa, close to the position of the foramen ovale. (GREGORY 1920:172.)

Once within the temporal fossa, this artery (which often obliterates during ontogeny) may anastomize with various vessels (see BUGGE 1974). However, its major areas of supply generally include the upper and lower jaws (through the ramus infraorbitalis and ramus mandibularis).

See fig. I-4.

RAMUS POSTERIOR (OF THE STAPEDIAL ARTERY)

A branch of the (proximal) stapedial artery which is released by the parent vessel just before the latter enters the obturator foramen of the stapes. It passes backwards out of the tympanic cavity in close relation to the facial nerve and the stapedius muscle. (See VAN VALEN 1966:9-10.)

This vessel is not usually identified for recent mammals. However, among the forms studied here, it is present in (?all) tenrecs, Solenodon, and at least young stages of Erinaceus. It may terminate in the stapedius muscle, or have a more extensive distribution which includes the lambdoidal region of the skull and the auricle.

See fig. I-4.

RAMUS SUPERIOR (OF THE STAPEDIAL ARTERY)

A branch given off by the (proximal) stapedial artery after the latter passes through the obturator foramen of the stapes, usually at the same time as the ramus inferior is released. The ramus superior passes through the roof of the tympanic cavity in order to enter the cranial cavity.

Within the cranial cavity, this artery (which rarely obliterates during ontogeny) may, like the ramus inferior, form various anastomoses with other vessels (see BUGGE 1974). Typically, however, it feeds the dura (by means of the middle meningeal) and the orbital area (by means of the frontal, ethmoidal, lacrimal and ciliary arteries).

See fig. I-4.

RECESSUS MEATUS

As conventionally used, the more or less well-defined, circular fossa produced external to the ventral part of the tympanic membrane as a result of the lateral broadening of the ectotympanic (or the entotympanic or petrosal plate). (See VAN KAMPEN 1905:358; VAN DER KLAAUW 1931:137.)

In fact, the recessus is never an empty space, but is always filled with the tissues of the membranous meatus.

RECESSUS SCALAE TYMPANI

The area in which the cul-de-sac of the scala tympani (a fluid-filled space of the perilymphatic labyrinth) is situated. In the adult mammal, the recessus lies behind the lower part of the secondary tympanic membrane. (See RICHANY, ANSON and BAST 1975:94-96.)

See PROCESSUS RECESSUS.

REICHERT's CARTILAGE
(DORSAL CARTILAGE OF THE SECOND BRANCHIAL ARCH)

The well-developed cartilage which forms from the second visceral (hyoid) bar. It is initially in continuity with the primordia of the crura of the stapes and the long crus of the incus. These associations are later lost, and the dorsal end of the cartilage then fuses with the crista parotica (q.v.) of the developing otic capsule. Ventrally, the cartilage articulates with the thyrohyal (third visceral bar).

There is great variety in the development of Reichert's cartilage in mammals. It may ossify from as many as four separate centers (in proximal to distal order, tympanohyal, stylohyal, ceratohyal, and hypohyal), or one or more of these centers may fail to appear. Also, two or more ossifications may fuse (as in man, where the styloid process represents the fused tympanohyal and stylohyal). (See CORSY 1933:234-260.)

For the association of Reichert's cartilage with the crista parotica, see TYMPANOHYAL.

Regarding the use of an eponymous name in this instance, see MECKEL's CARTILAGE.

ROSTRAL ENTOTYMPANIC

An entotympanic which arises in the rostral part of the ventral wall of the tympanic cavity. It may be intimately fused with the cartilage of the tube during the early phases of its development.
See ENTOTYMPANIC(S).

ROSTRAL TYMPANIC PROCESS OF THE PETROSAL
(PROCESSUS TYMPANICUS PETROSI CAUDALIS)

As used here, any bullar wing which arises primarily from the ventral surface of the promontory of pars cochlearis.

It makes its first appearance as a periosteal outgrowth of the promontory after the latter is already highly ossified. Typically, it lacks preformation in primary cartilage, although secondary cartilage may appear within it later in ontogeny.

In the forms considered here, it apparently never has its own center of ossification.

See PETROSAL PLATE.

SECONDARY TYMPANIC MEMBRANE
(MEMBRANA TYMPANI SECUNDARIA)

The trilaminar membrane which closes the fenestra cochleae and separates the scala tympani from the tympanic cavity. (RICHANY, ANSON and BAST 1975:96.)

SEPTUM

As used here, any cartilaginous or bony revetement projecting into the middle ear spaces. Septa may be complete or incomplete, depending on whether they define whole compartments or merely provide relief within large cavities. They are often associated with canals for blood vessels.

STAPEDIAL ARTERY
(A. STAPEDIA)

"The stapedial artery develops early from an anastomosis through the stapes blastema, between the rudiments of the first and second aortic arches, and fully elaborated comprises a supraorbital branch supplying the dura and orbit and an infraorbital branch and mandibular branch supplying the upper and lower jaws respectively" (BUGGE 1974:15).

If preserved, it appears as the lateral of the two branches formed by the bifurcation of the internal carotid in the adult. From its origin it passes through the obturator foramen of the stapes and ascends to the roof of the tympanic cavity. It may release up to three branches during its course through the middle ear. Here, the traditional names for these branches are used: ramus inferior ("distal part of the stapedial stem" of BUGGE 1974), ramus superior (intratympanic portion of ramus supraorbitalis of BUGGE 1974), and ramus posterior (not named or described by BUGGE 1974).

In order to avoid ambiguity, the section of the stapedial artery extending from its origin to the point of bifurcation into inferior and superior rami (or to the place where it leaves the tympanic cavity if no bifurcation occurs) will be termed the "proximal part of the stapedial stem" or simply, "proximal stapedial".

STAPEDIUS MUSCLE
(M. STAPEDIUS)

The small muscle which originates from the rear of the otic capsule, medial to the prominence of the lateral semicircular canal, and which inserts into the neck of the stapes by means of the stapedius tendon. It is innervated by the stapedius nerve of the facial. Its action is to draw the head of the stapes backward and rotate the anterior end of the base or footplate outward, thus tensing the anular legament. (See SISSON 1939:900.)

STYLOMASTOID FORAMEN
(FORAMEN STYLOMASTOIDEUM)

The foramen by means of which the facial nerve finally leaves the middle ear. Two conditions of this foramen are usually distinguished. The "foramen stylomastoideum primitivum" (BROMAN 1899) is not a foramen at all, in the sense of an aperture enclosed by bone or cartilage. Instead, it marks the place where the facial nerve penetrates the fibrous tissue adjacent to Reichert's cartilage (or the tympanohyal) in order to descend into the upper neck. The foramen stylomastoideum primitivum is a constant feature of the mammalian fetus, and is also found in the adult stage of forms in which tympanic processes fail to enclose the facial nerve at its point of departure from the middle ear.

The "foramen stylomastoideum definitivum" may be thought of as the ontogenetic successor of the foramen stylomastoideum primitivum. It is properly identified only in those cases where the petrosal (or, occasionally, the entotympanic or ectotympanic) alone or in combination with the tympanohyal forms a definite aperture.

Where useful, the primitive and definitive conditions of the foramen are distinguished in the text. Where not, the neutral term "stylomastoid foramen" will be used (cf. MCDOWELL 1958:128).

SUPRACOCHLEAR CAVITY

A term coined here to refer to the space which develops from the medial part of the epitympanic recess through the pneumatization of the bone of the dorsal (cerebral) wall of pars cochlearis.

See MEDIAL ACCESSORY CAVITY.

TEGMEN TYMPANI

An initially-cartilaginous process of the anterolateral edge of the canalicular part of the auditory capsule which provides part of the roof of the tympanic cavity in mammals. The root of the tegmen is crossed by the facial sulcus. (See DE BEER 1929:418.)

TENSOR TYMPANI MUSCLE
(M. TENSOR TYMPANI)

The small muscle which originates from the sphenoid, extensions of the cartilage of the tube, petrosal, and, occasionally, from the membrane covering the piriform fenestra. It lies along the dorsomedial wall of the tympanic cavity covered by a dense layer of mucous membrane and extends posteriorly in the fossa of the tensor tympani to approximately the level of the apertura fenestrae vestibuli; along this course or in front of the apertura it bends laterally and attaches to the muscular process on the inner surface of the neck of the malleus. (HENSON 1961:163.)

It is innervated by a branch of the mandibular division of the trigeminal nerve (n. tensoris tympani) through the otic ganglion. Its action is to draw the handle of the malleus inward, thus tensing the tympanic membrane.

TRIGEMINAL GANGLION
(G. TRIGEMINALE, GASSERIAN G., SEMILUNAR G.)

The large ganglion which gives rise to the ophthalmic, maxillary and sensory part of the mandibular nerve. It is accommodated in the prominent fossa (impressio trigeminalis) on the dorsal (cerebral) aspect of the alisphenoid and contiguous part of the petrosal. (See JOHNSTON et al. 1958:1100.)

TRIGEMINAL (V) NERVE
(N. TRIGEMINUS)

The largest cranial nerve. It is the sensory nerve of the face, the greater part of the scalp, the teeth, the mouth and the nasal cavity, and the motor nerve of the muscles of mastication and soem other muscles. It divides into three branches, the ophthalmic (V_1), the maxillary (V_2) and the mandibular (V_3). (DAVIES 1967:1143.)

TUBAL CANAL (FORAMEN, GROOVE)

The aperture or incisure through which the auditory tube enters the tympanic cavity.

TUNICA MUCOSA OF THE TYMPANIC CAVITY
(MUCOUS MEMBRANE OF THE TYMPANIC CAVITY)

The membrane which lines the walls and spaces of the middle ear and invests its exposed contents (e.g., ossicles, muscles, nerves, arteries). The lining is continuous anteriorly with the mucosa of the auditory tube and posteriorly with that of the mastoid cavity (if formed). (See ANSON and DONALDSON 1973:169.)

TYMPANIC CANALICULUS
(CANALICULUS TYMPANICUS)

The small foramen in the petrosal by means of which the tympanic nerve of the glossopharyngeal enters the tympanic cavity. (ANSON and DONALDSON 1973:10.)

TYMPANIC CAVITY

In the adult, the osseous chamber of the basicranium which contains the cavum tympani (q.v.).

Included within it are the structures of the middle ear concerned with the actual mechanics of transforming air vibrations into vibrations strong enough to move the fluids of the inner ear: the auditory ossicles, ossicular muscles, and the fenestrae vestibuli and cochleae. (WEBSTER 1966:452.)

TYMPANIC MEMBRANE
(MEMBRANA TYMPANI, EARDRUM)

The membranous partition between the external and middle ears which is involved in the conduction of sound to the ossicular chain.

It consists of two portions, the pars tensa (attached to the tympanic sulcus of the ectotympanic) and the pars flaccida (lying between the tympanic notch and the adjacent part of the roof of the external acoustic meatus).

These two portions differ in their composition. Pars flaccida is bilaminar (formed by the skin of the meatus and the tunica mucosa), while pars tensa is trilaminar (formed by the two preceding tissues and an intervening, double-layered stratum). (See ANSON and DONALDSON 1973:164-165.)

TYMPANIC MUCOID TISSUE

The tissue which initially fills much of the presumptive tympanic cavity. It is at first embryonic mesoderm, then differentiates into a myxomatous (mucoid) tissue which undergoes resorption as the early cavum tympani expands and pushes it aside. It is mostly resorbed by late fetal life (in Homo), although some remains as the so-called mucoperiosteal layer of the tunica mucosa. (PEARSON and JACOBSON 1967:6-9.)

TYMPANIC NERVE
(N. TYMPANICUS, N. OF JACOBSON)

The tympanic nerve arises from the distal (or inferior) ganglion of the glossopharyngeal and passes upward between the petrosal and the ectotympanic to reach the tympanic cavity. Within the tympanic cavity

it sends branches to the tympanic plexus. (SISSON 1938:825.)
See fig. I-4 and LESSER PETROSAL NERVE.

TYMPANIC NOTCH
(INCISURA TYMPANICA, NOTCH OF RIVINUS)

See ECTOTYMPANIC.

TYMPANIC PROCESS

A general term used here for any bony or cartilaginous outgrowth which contributes to the floor of the middle ear.
See EPITYMPANIC WING and fig. I-2.

TYMPANIC PROCESS OF THE ALISPHENOID

An outgrowth of the rear of the alisphenoid which bounds the anterior end of the tympanic cavity in certain mammals (e.g., many marsupials, lipotyphlans). See fig. I-2.

TYMPANIC PROCESS OF THE BASISPHENOID

An outgrowth of the lateral margin of the basisphenoid which helps to bound the medial side of the tympanic cavity. It may be insignificant in size (e.g., elephant shrews), or may form most of the bony ventral wall (e.g., golden moles). The ontogenetic evidence indicates that its anterior part almost always includes material derived from the pterygoid bone. See fig. I-2.

TYMPANIC SULCUS
(SULCUS TYMPANICUS)

The groove channeling the inner circumference of the ectotympanic, to which the tympanic membrane is attached by means of the fibrocartilaginous ring (anulus fibrocartilagineus). (ANSON and DONALDSON 1973: 165.)

TYMPANOHYAL

The most proximal of the ossification centers which may form in Reichert's cartilage. It is known by a variety of names, including laterohyal, epihyal, and 'hyoid' process. Usually indistinguishably fused with the petrosal (crista parotica) by the late fetal stage. (See DE BEER 1937:372.)

It should be noted that it is conventional to call any projection immediately in front of the stylomastoid foramen a 'tympanohyal'

(in the adult), but this implies a knowledge of the method of ossification of Reichert's cartilage which is often lacking. The dorsal part of the cartilage may fail to ossify independently, and an observed projection may actually consist of petrosal material.

VAGUS (X) NERVE
(N. VAGUS)

The cranial nerve with the most extensive course and distribution, since it passes through the neck and thorax to the abdomen. Issues from the posterior lacerate foramen (q.v.). (JOHNSTON *et al*. 1958: 1130.) (See fig. I-4.)

VERTEBRAL ARTERIES
(AA. VERTEBRALES)

See BASILAR ARTERY.

VISCERAL BAR

Term for the entire block of condensed mesenchymal tissue (or later, cartilaginous tissue) which forms in a given branchial arch. (PEARSON and JACOBSON 1967:16-17.)

Thus, Reichert's cartilage and its subdivisions, the manubrium of the malleus and the long crus of the incus are all products of the second visceral bar.